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NATURAL HISTORY

VOL. XIX · MARCH 1919 · NUMBER 3

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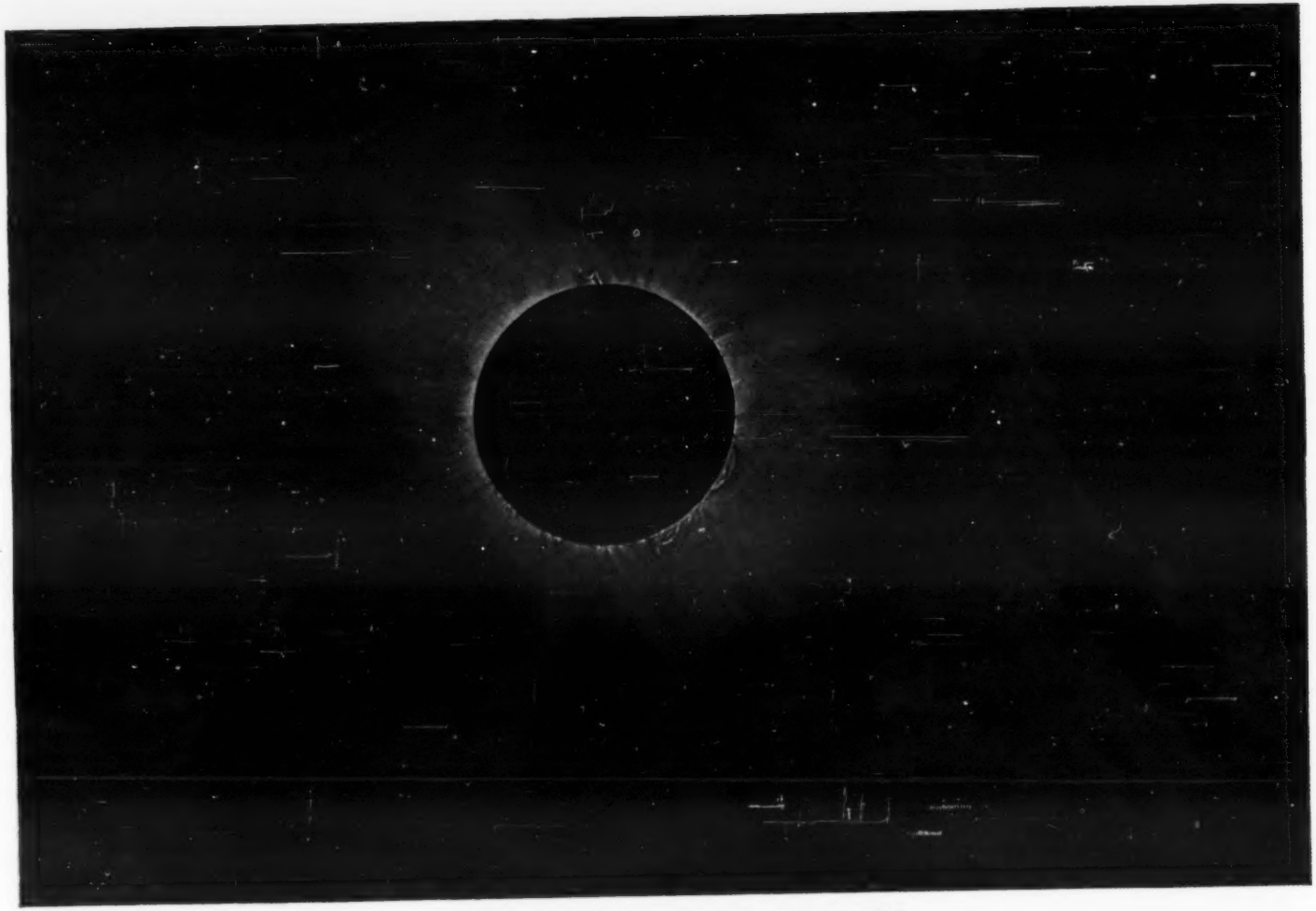
GIGANTIC PROMINENCES ON THE SUN'S LIMB

During the eclipse, flames of hydrogen gas were seen to shoot out from the sun's surface at velocities sometimes as great as a hundred miles a second, reaching such colossal distances as 480,000 miles. The upper prominence in the picture, which resembles some great monster, is at least 47,000 miles high. Fiery streamers trail from each of the outbursts as though blown by an equatorial gale.

This photograph was made at Green River, Wyoming, by Professor E. E. Barnard of the Yerkes Observatory, with a camera of 61½ feet focus. With shorter exposure the lower prominence is shown in delicate detail as made up of thin fiery filaments



TOTAL ECLIPSE OF THE SUN, JUNE 8, 1918

From the painting by Howard Russell Butler, N. A.

The corona and prominences as observed through thin clouds at the United States Naval Observatory Station, Baker, Oregon.
(Original size of painting 49 x 38½ inches)

NATURAL HISTORY

VOLUME XIX MARCH, 1919 NUMBER 3

The Total Solar Eclipse of 1918

By S. A. MITCHELL

Director of the Leander McCormick Observatory, University of Virginia

WHO is not interested in a total eclipse of the sun? He who has once seen such an eclipse can never forget it; the slow but gradual obscuration of the sun, the darkness covering the face of the earth even at noontime, and the glorious sight that meets the eye during the few short minutes of totality! It is no wonder, therefore, that in the early days of the world's history these wonderful phenomena should have been looked upon with great fascination and dread, and that the astronomer—and more often the astrologer—should have been regarded as almost a demigod because of his ability to predict the coming of eclipses. But with the increase of knowledge and the progress of science, the astronomer has gradually been dragged from his lofty pinnacle of fame, until now in the twentieth century the popular fancy pictures him as a foolish old man who would rather stay up at night and do his work than act as an ordinary civilized human being.

Not only do eclipses appeal to the popular imagination by their spectacular beauty, but there is also a great fascination to the lay mind in the almost uncanny power with which the astronomer is able to predict, years in advance, the exact time at which an eclipse will take place, where this eclipse may be seen, and how long this eclipse will last. As a matter of fact, Oppolzer's "Canon der Finsternisse" gives the elements of no fewer than 13,000 eclipses, both of sun and moon, partial and total—all the eclipses, in fact, which have taken place since the year 1207 B.C. or which will be seen before the end of the year 2152 A.D. Maps are given in this great work which, almost at a glance, tell when and where an eclipse was seen three thousand years ago, or where an eclipse may be observed two hundred and fifty years in the future.

The earliest recorded eclipse is that which was seen in China in the year 2136 B.C., or more than four thousand years ago! An account of this eclipse is given in one of the ancient Chinese classics. This eclipse, which was not a total eclipse, had rather direful consequences for the two royal astronomers Hi and Ho, who instead of staying in the sober paths of science for this important occasion, went and got drunk. In order that a terrible warning might be given to all future generations of astronomers, who might be tempted to follow in their footsteps, the emperor ordered that both have their heads chopped off.

The progress of science during the last fifty years is nowhere better illustrated than in the attitude of astronomers toward observations at the time of a total eclipse of the sun. Up to the middle of the last century, the only observations that were made at the time of a total eclipse were for the purpose of perfecting the tables of motion of

the moon, by noting the exact times of contact of the limbs of the sun and moon. The beautiful corona was watched with awe and admiration, and a few sketches were made of its form, —but there the study of an eclipse ended. In fact, an eclipse was watched only if the shadow happened to cross the observer. So little interest was taken in the phenomena, so few investigations were planned, that no expeditions were sent out.

How different is the scientific attitude in the twentieth century! In the year 1901, the writer of this article traveled halfway round the world to the far-off Dutch East Indies in order to observe the total eclipse of May 18 of that year. In other words, he went as far from home as it was possible to go, and the purpose of this trip was to make observations which were concentrated within the time of six short minutes.

The writer regards himself as very fortunate in having been selected four times to become a member of the party of the United States Naval Observatory, and he has thus seen the eclipses of 1900, 1901, 1905, 1918, and altogether has traveled about 40,000 miles for this purpose.

As a matter of fact, an eclipse is not of the rare occurrence that the foregoing remarks might lead one to believe. Each and every year there must be two eclipses of the sun, and there may be even more. Somewhere on the earth each year two eclipses of the sun may be observed, but usually these eclipses are partial eclipses, the sun being only partly obscured. Since few scientific facts can be learned at a partial eclipse, the astronomer takes little interest in them. It is only when the sun's surface is wholly covered up that the matchless corona may be seen; it is only at the time of a total eclipse that there is furnished the unusual opportunity of investigating the sun's surroundings when the brilliant glare of the sun itself is absent.

About once every two years a total eclipse may be seen somewhere on the earth's surface, but as some of these eclipse tracks lie almost wholly on the water surface of the earth, or fall upon inaccessible portions of the globe, it is only on an average of about once in three years that a total eclipse falls at a habitable spot on the earth, even though that location, as in 1901, may be so far away. On the average a total eclipse lasts for about two minutes, so that in a century, about sixty minutes, or one short hour of time, is given to the astronomer for his investigations. Yet in spite of the brevity of time afforded, some very startling results have been accumulated!

As is well known, an eclipse takes place when the sun, earth, and moon are in a straight line, an eclipse of the sun occurring when the moon comes between the sun and the earth, or when the earth passes into the shadow cast by the moon. The earth makes an annual journey about the sun, traveling in the ecliptic at the speed of more than eighteen miles a second, and accomplishing its journey in 365¼ days. The distance from the sun is on the average of ninety-three millions of miles, but the earth's orbit is not a circle but an ellipse, so that the distance from sun to earth may vary one and a half million miles on either side of the mean. Once a month, the moon revolves about the earth, but it likewise does not move in a circle so that the distance from earth to moon varies considerably on either side of the average of 239,000 miles. Moreover, the moon's path is not exactly in the plane of the ecliptic, but is inclined to the ecliptic by a small amount, a little more than five degrees of angle. An eclipse of the sun can take place only at the time of new moon, so that manifestly it is only at the time of new moon, when in addition the moon is near the plane of the ecliptic, that an eclipse of the sun can take place.

Although the average motions of the moon have for some time been so well known that the general time and locations of eclipses may be predicted at long range with a considerable degree of accuracy, still it may be truthfully said that the moon has given the mathematical astronomer more work and worry than all the millions of stars of the universe, with the result that to predict the time of coming of an eclipse at any one locality exactly to the fraction of a second taxes the ingenuity of the astronomer even today. It is no wonder, therefore, that man should always have regarded the moon as of the feminine gender!

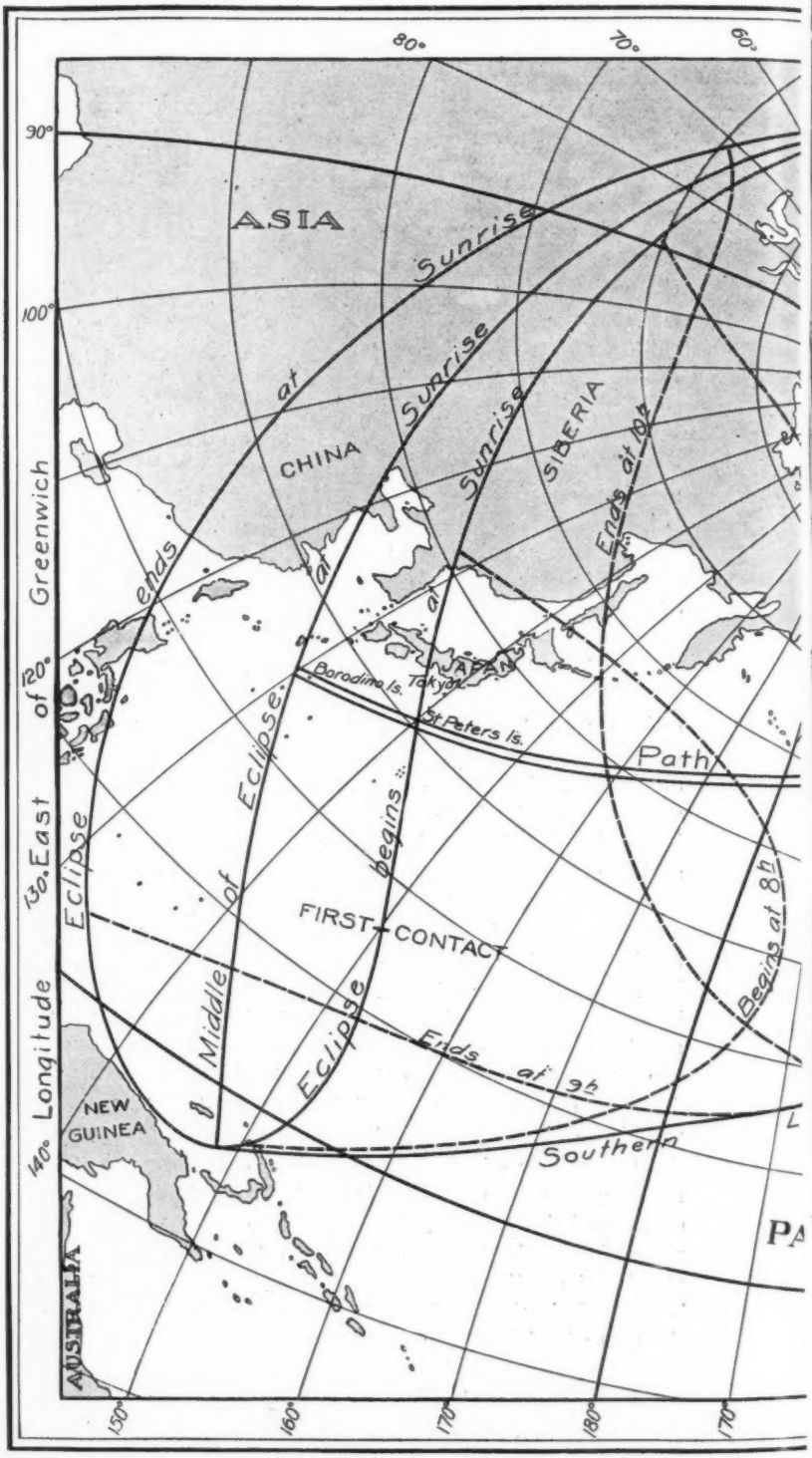
The distance and dimensions of the sun and moon being known, it is comparatively easy to find out the diameter of the moon's shadow intercepted by the earth. The maximum width of the shadow is 168 miles, and when all conditions are most favorable, the total eclipse may last for somewhat more than seven minutes. Under average conditions, the region on the earth where the total eclipse may be observed is less than one hundred miles in width, and the average duration of totality is about two minutes of time. The chance that the stay-at-home might see many total eclipses in his lifetime is very limited. As a matter of fact, in London before the eclipse of 1751, there had not been a single total eclipse of the sun visible for more than six centuries. At any one location, an inhabitant would see many more total eclipses of the moon than of the sun. When the moon passes into the shadow of the earth and is eclipsed, then wherever upon the earth's surface the moon is visible, the eclipse may also be seen. The result is that each total eclipse of the moon is visible over more than half the earth, while on the other hand the total solar eclipse is visible only over a narrow track.

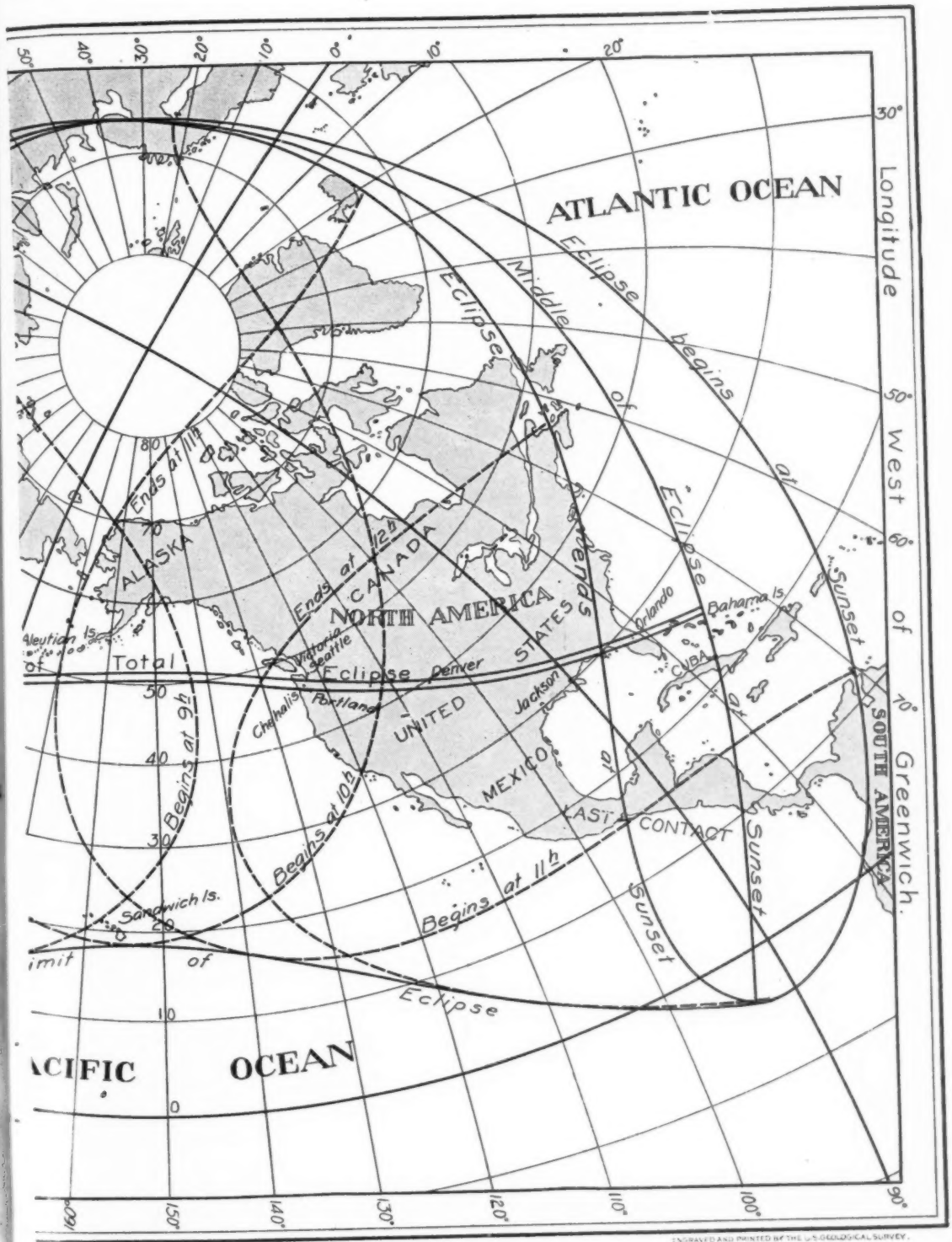
Ordinarily a total solar eclipse attracts astronomers from all quarters of the globe for the purpose of making observations. Thus in 1901, in far-distant Sumatra, in addition to a large party from the United States, there were gathered astronomers from England, France, Germany, Holland, and Japan. For the eclipse of 1905, which took place in Europe, there were congregated in the eclipse track, hundreds of astronomers, professional and amateur, from every civilized nation of the world. The trip in 1901 was a most fascinating one, including as it did a journey across the continent to San Francisco; from the Golden Gate to Manila, stopping *en route* for three days at Honolulu; and ten or a dozen days' stay in Manila while waiting for the United States gunboat which took the party the remaining 2200 miles along the coast of Palawan and Borneo, across the equator, and through the Strait of Sunda to the west coast of the Island of Sumatra. A stay of eight weeks in the interior of the island was necessary in preparation for the eclipse, a site having been chosen at the terminus of the government railroad. The country was picturesque, the manners and customs of the people most interesting, for, belonging as it does to the Dutch, who have peculiar ideas of their own regarding colonization, few foreign influences had been allowed to disturb the primitive lives of the natives. Indeed, ten miles due east of the eclipse camp so little is known of the country that it is said cannibals are still in existence there.

In 1905 there was another attractive trip, when a voyage was made across the Atlantic aboard the U. S. S. "Minneapolis" which was the flagship of Rear Admiral Chester, then Superintendent of the United States Naval Observatory. At Gibraltar, we had the pleasure of viewing the British Mediterranean fleet with Admiral Lord Beresford in command. Eclipse observations were made from the little town of Daroca in the interior of Spain

PATH OF THE TOTAL ECLIPSE OF THE SUN, JUNE 8, 1918

The sun could be seen totally eclipsed only in the area bounded by the two close parallel lines, which is about sixty miles wide. Outside of this area the sun was partly eclipsed. At sunrise the eclipse began in the Pacific Ocean off the coast of China and Japan. The shadow traveled across the Pacific at the rate of more than a thousand miles an hour so that it reached the United States well after noon. It is notable that with the exception of a few small islands the only land touched by the moon's shadow was the American Continent




ATLANTIC OCEAN
NORTH AMERICA
ALASKA
CANADA
UNITED STATES
MEXICO
CUBA
Bahama Is.
Orlando
SOUTH AMERICA
Aleutian Is.
Victoria
Seattle
Chehalis
Portland
Denver
Jackson
Sandwich Is.
Total Eclipse begins at Sunset
Middle of Eclipse at Sunset
Eclipse ends at 12h
Ends at 11h
Begins at 9h
Begins at 10h
Begins at 11h
LAST CONTACT
Eclipse
Longitude 50° West of 10° Greenwich.
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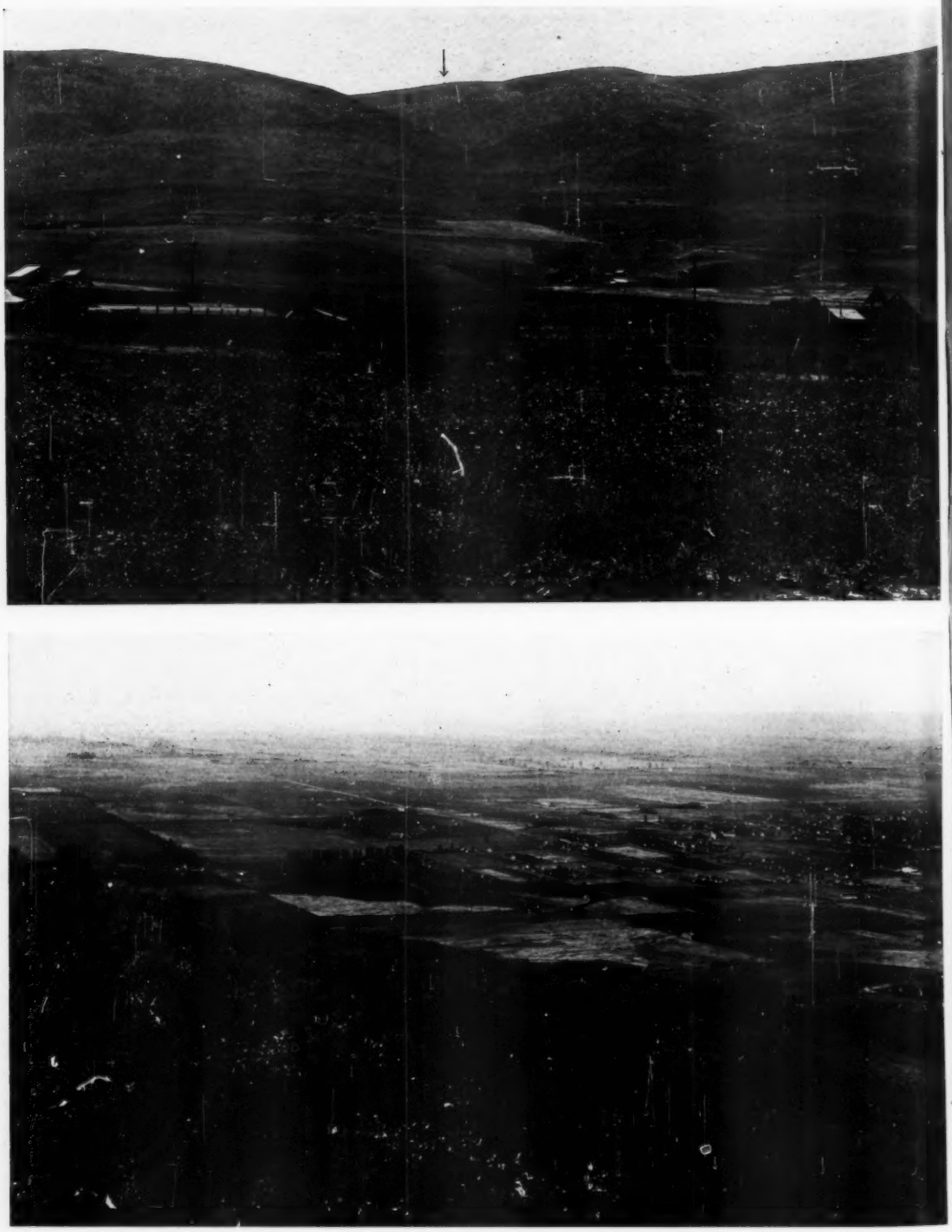


FOOTHILLS OF THE ELKHORN RANGE BEHIND THE CITY OF BAKER (UPPER PICTURE)

The city of Baker obtains its water supply from the melting snows of the Elkhorn Range (the pipe line comes over the hills at the point indicated by the arrow). On the day of the eclipse the citizens of Baker repaired to these foothills, from which they could obtain a fine view of the range and the valley, to watch for the shadow of the moon, which rushed across the landscape at the instant of totality with the great speed of about thirty miles a minute

THE CITY OF BAKER, OREGON (LOWER PICTURE)

Baker is situated at an altitude of 3500 feet and promised to afford to the observers of the United States Naval Observatory an excellent opportunity to study the eclipse, with an abundance of clear sky in June; as it turned out, however, cloudy weather nearly prevented the work of the expedition. The city is on the main line of the Union Pacific system to Portland, a fact taken into consideration in the selection of the site on account of the necessary transportation of numerous instruments

which had boasted a railroad for only four years, but where civilization had existed for more than 2200 years as was shown by an old Roman fort still in a good state of preservation. A visit from the New World to this old and worn-out kingdom was not without its fascination.

The eclipse of the year 1918 took place on June 8. The shadow of the moon first touched the earth's surface on the Pacific Ocean, far south of Japan. Due to the revolution of the moon about the earth, and to the rotation of the earth on its axis, the moon's shadow crossed the Pacific Ocean at a speed well over a thousand miles an hour. It was well after noon before the shadow reached the American continent, and the eclipse began in the state of Washington. Here the width of the shadow was only sixty miles so that only those fortunate enough to be within this narrow track were able to see the eclipse in its totality. The eclipse passed southeasterly through Washington, Oregon, Idaho, Wyoming, and Colorado in succession. In Colorado the shadow had dwindled to forty miles in width. After passing through some of the central states, the shadow left the United States at Florida and left the earth's surface in the Atlantic, off the coast of the Bahama Islands.

The eclipse was seen almost exclusively from the United States, and so it will be known as the American Eclipse of 1918. As more than half the civilized world was in the grip of the tremendous war, it was necessary for the American astronomers in the year 1916 and early in 1917 to make their plans to see to it that this eclipse should be well observed. Before our own country had become involved in the war, Congress had been asked for and had made a special appropriation to defray the expense of equipment and travel for the party from the United States Naval Observatory.

The exact location of an eclipse site is of the greatest importance, since the utmost care must be exercised to choose one where the chances of clear skies will be as great as possible. Think of the disappointment of finding only cloudy skies on the all-important day! Even one small, dense cloud hanging over the sun during totality would render useless all the active months of preparation, would make of no avail the delicate apparatus carefully adjusted after arduous toil, and make of no account the carefully prepared plans for scientific work. The majority of the members of the Naval Observatory party to Sumatra in 1901 had no results to show for their long trip which consumed about six months. Not only must a location be chosen where good weather is promised, but the location should be convenient to a railroad, and at or near a town so that the observers may be properly housed and fed without the necessity of forming a camp with extra arrangements for cooking, etc. In addition, most classes of eclipse work require a location as near as possible to the central line of the moon's shadow.

In order to help the astronomers make as intelligent a choice of an eclipse site as possible, the Naval Observatory, in 1917, had prepared a large scale map of the United States showing among other things, railroad lines, contour lines, and the location of towns, within the eclipse track. The city of Baker, in eastern Oregon, seemed to be the ideal spot for the government party, since the weather of early June promised an absence of rain, with an abundance of clear skies. This city, of about ten thousand inhabitants, is on the main line of the Union Pacific system to Portland, and at an altitude of about 3500 feet.

In order to set up and adjust the apparatus, five of the party left the East about April 20. The party consisted of Mr. J. C. Hammond, Astronomer of the Naval Observatory, in charge of the

expedition, Mr. W. A. Conrad and Mr. C. C. Wylie, assistants at the Naval Observatory, and Dr. L. G. Hoxton and Dr. S. A. Mitchell, of the University of Virginia. After locating ourselves at the Antlers Hotel, we viewed the city in order to find the best site for the eclipse location. Through the kindness of the Chief Engineer of the Union Pacific system, who provided us with excellent photographs and topographic maps, we were not long in deciding upon the Fair Grounds on the edge of the city as the most convenient spot. This was fairly near to the hotel where we lived, the grounds were surrounded by a high board fence which would serve to keep out the idly curious, and the buildings in the grounds were adequate to house our valuable apparatus until put in place. We were in Baker exactly six weeks before eclipse day, and the time was none too long. The apparatus was sent forward by through freight, and although we greatly feared delays, it arrived safely the second day after our own arrival. To assist in the work of erecting the apparatus, the superintendent of the Naval Observatory had requested the services of five sailors from the United States Naval Station at Bremerton, Washington, who were in charge of a chief petty officer. The sailors were carpenters and machinists who assisted the astronomers in splendid style so that ten days before the eclipse, when the rest of the party began to arrive, the apparatus was all erected and partly adjusted, and there remained only the perfecting of the adjustments in order to be ready for the all-important day of the eclipse.

An idea of the scope and difficulty of the work to be attempted may perhaps be best visualized by the realization that it took five astronomers and half a dozen sailors six weeks to have things ready for the final adjustments.

But what, people ask, is to be learned at the time of an eclipse? Why these expeditions which at times go so far afield, these elaborate preparations which must run the risk of accomplishing nothing on account of the clouds? Surely there must be something of great importance to be learned in order to warrant such an expenditure of energy and money. Perhaps the best way to answer these questions would be to take up in detail the scientific program of the party of the United States Naval Observatory which was carried out at Baker, giving a brief account of the apparatus necessary and the problem attacked.

The first problem for a government expedition to attempt must necessarily be the determination of the precise times of contact of the limbs of the sun and moon. The *American Ephemeris and Nautical Almanac* is published each year in Washington at the Naval Observatory. This book gives the exact place of the sun, moon, planets, and stars; for each and every day at noon, in the case of the sun, for each and every hour for the moon, and at longer intervals for the planets and stars. The positions are tabulated three or four years in advance, and the positions determined are constantly checked up by observations. On account of the fact that the moon is such a near neighbor, its motion is very complicated. It is very necessary to make the computed positions agree with those calculated. One of the best ways of finding the exact position of the moon is to note the times of contact of its limbs with those of the sun at the time of an eclipse. At the eclipse of 1905, the programs of observation were somewhat disarranged by the fact that total eclipse took place ten seconds earlier than the calculated time. In 1918, it was expected that the eclipse in Baker would begin about twelve seconds earlier than the time as computed from the *American Ephemeris*. To compute the phases of the eclipse one must know with accuracy the exact latitude and longitude of the eclipse location. This part of the

eclipse work in Baker was under the direction of Mr. J. C. Hammond of the Naval Observatory, and in the observations he was assisted by Mr. Wylie, by Mr. Conrad, and, to a lesser degree, by Chief Petty Officer Patrick Welsch. The latitude and longitude were determined by observations on stars on a dozen or more nights during the weeks of preparation for the eclipse. Since longitude is measured by the difference in time between any two places, it was necessary to determine the exact time at Baker, and at the same instant find the exact time at Washington. Since the longitude at Washington with respect to Greenwich is known, this would give the longitude of Baker with respect to Greenwich. In order to determine the difference in time between Washington and Baker, it was necessary to connect the two places with a direct telegraph line. On switching on the current, the beats of the clock could be heard by the relay in Baker, and a record of these could be made by means of the chronograph. Similarly, the beats of the chronometer used in Baker could be recorded in Washington. In this manner signals were exchanged between the two places on four different nights, with the result that the exact location of the eclipse site on the surface of the earth is known within an error that does not exceed fifty feet.

There is a popular belief to the effect that since a telescope is used to magnify objects, and to show them in greater detail, then of necessity a very large telescope must greatly enhance the beauties of all objects in the sky and make the corona even more beautiful than it appears to the naked eye. This, however, is not the case. This splendid feature of the eclipse owes its charm to its delicate shadings of pearly light, stretching at times to two, three, or more diameters of the sun from its surface. But increase of magnifying power usually means decrease in the size of the area visible at one time, so that while a great telescope shows a small portion of the corona highly magnified and in great detail, the beauty of the spectacle as a whole is lost. As a matter of fact, the most satisfactory view of the corona is obtained with the naked eye, though a good pair of field glasses may aid in showing some of the features in better detail. The telescope used by Mr. Hammond on June 8 for observing the times of contacts was not a large telescope, but one of the moderate size of five inches in aperture.

During the weeks of preparation, an opportunity was afforded the citizens of Baker to view the moon and some of the planets and brighter stars through this instrument, and many availed themselves of the chance to see the "Man in the Moon," often standing in line for an hour or more, with the thermometer near the freezing point, in order to get their turn for a "look through."

The scientific program of the party which was readily understandable to the residents of Baker who came to the Fair Grounds to see the apparatus erected was the work of the cameras, large and small. These telescopes or cameras were used on eclipse day to photograph the corona and prominences with a greater or less scale. A camera of short focal length gives only a small sized picture, an ordinary kodak showing the sun about the size of the head of an ordinary pin. The greater the focal length of the camera employed, the larger the resulting photograph of the sun. The largest camera used at Baker had a focal length of no less than sixty-five feet. We are all of us familiar with the use of a kodak and the methods by which snapshots are taken, but how handle such a big camera? There are but two methods. One is to mount the huge instrument in such a fashion that at eclipse time it will point directly at the sun. A simple calcula-

tion serves to orient the camera correctly, but the satisfactory erection is a more difficult matter, since any shake given to the camera itself would be communicated to the lens and to the photographic plate. Even a very slight disturbance of the camera would blur the photographed image and make it scientifically useless. But how support such a huge instrument without a tremor? Even a gentle wind would be sufficient to shake it, and eastern Oregon promised an almost certain high wind at eclipse time. This problem was solved by Schaeberle of the Lick Observatory twenty-five years ago, when it was found necessary to build a double tower, the inner one of which supported the lens while the outer one acted as a wind screen. Another complication arises due to the fact that the exposures necessary to obtain the corona last for many seconds of time, sometimes totaling sixty or even one hundred in length. With a telescope of sixty feet focal length, the westerly motion of the sun in the sky causes the image of the sun to move on the photographic plate about one eighth of an inch every minute. Evidently some mechanism must be used to counteract this motion. This is accomplished by a clock mechanism, the details being thoroughly understood.

The Lick Observatory of the University of California has been most assiduous in its observations of eclipses, and more than a dozen expeditions have been sent out to all parts of the globe. This splendid scientific record has been made possible through the generosity of Mr. William H. Crocker, of San Francisco. The Lick parties have always adopted the same method of photographing the corona—that of pointing their camera directly at the sun.

Owing to the difficulty of erecting a double tower, most other astronomers follow the mechanically simpler plan of laying the camera tube horizontally and allowing sunlight to be fed into it by means of a plane mirror driven by clockwork to counteract the westward motion of the sun. Needless to say, the irregularities of the driving mechanism will affect the exact definition of the photograph—this being the chief drawback to this type of mounting. In addition to the sixty-five foot telescope, the Naval Observatory had two smaller cameras, of 104 inches and 36 inches respectively. On eclipse day, the large instrument was in the hands of Mr. W. A. Conrad, of the Naval Observatory staff, and the successful completion of his program demanded that Mr. Conrad remain closed inside his darkroom during the whole of totality with never a single chance to gain even a glimpse of the corona. The other cameras were used by Mr. G. H. Peters and Mr. C. C. Wylie, also of the Naval Observatory staff. Two smaller cameras pointing directly at the sun were employed by Mr. Kempton Adams.

Photographic work of a vastly different character from that of these cameras, large and small, was demanded by the spectroscopic work. At the eclipse which took place just fifty years ago, in 1868, the spectroscope was employed for the first time. By its use, Janssen in India saw the bright lines in the spectra of the prominences which proved that these outbursts from the sun were masses of heated hydrogen gas. These flames from the solar furnace are shot to enormous distances from the surface of the sun, being sent upward at times with a velocity of one hundred miles a second! Such colossal distances as 480,000 miles from the surface of the sun have been reached. How puny in comparison with such outbursts on the sun are the explosions of dynamite, or the deadly TNT on this little earth of ours!

The spectroscopic work at the time of an eclipse is for the purpose of supplementing such information as is gained daily by the same instrument. The most famous observatory in the

world devoted to solar research is the Carnegie Solar Observatory on Mt. Wilson in California. There, under the direction of Dr. George E. Hale, many startling revelations regarding the central luminary of our system have been made. The dark lines in the spectrum of the sun are caused by the absorption of light from the white-hot body of the sun as it passes through the cooler layers of atmosphere encircling the sun itself. But these layers of atmosphere are cool only in contrast with the much hotter sun. The gases are in fact very hot, and would give their spectra of bright lines if the still brighter background of the sun could be cut off. At eclipse time the moon comes between us and the sun. As long as there is only a small portion of the sun visible, its light is so intense that the spectroscope gives the ordinary solar spectrum. At the instant that the moon entirely covers up the surface of the sun, the solar spectrum suddenly changes from a spectrum of dark lines on a bright background to bright lines on a dark background. The change is so sudden that Young, of Princeton, who first saw it at the eclipse of 1870, named it the "flash spectrum." This flash spectrum lasts for the brief space of about three seconds of time at the beginning of the total phase, and again at the end. It was not until 1893 that the first photograph was obtained of the flash spectrum. At each succeeding eclipse, the photography of this spectrum has been, perhaps, the most important problem to be attacked. The eclipse of 1905, visible in Spain, gave the most perfect photographs of this phenomenon yet obtained. These photographs furnish us with much information of value regarding the physical constitution of the atmosphere of the sun, the height in miles to which these various gases extend above the surface of the sun, and other details of similar character. It may almost be said that we have more accurate information as to the constitution of the atmosphere of the sun nearly ninety-three million miles away than we have of our own terrestrial atmosphere ten miles above our heads.

The spectroscopic work of the Naval Observatory party for 1918 was planned in the hope of surpassing even the excellence of the photographs of 1905, but mainly with the intention of extending our spectroscopic knowledge much farther toward the red end of the spectrum than had been accomplished by other eclipse observers. Three separate instruments were used, each consisting of a Roland concave grating. The scientists engaged in the spectroscopic program were Dr. P. W. Merrill, of the Bureau of Standards of Washington; Dr. Harriet W. Bigelow and Dr. Mary Murray Hopkins, both of Smith College; and Dr. L. G. Hoxton and Dr. S. A. Mitchell, of the University of Virginia.

Fortunately for the work of preparation, no rain fell during the entire stay of the astronomical party in Baker. According to the "oldest inhabitant," the season was unusually dry even for eastern Oregon. By some mysterious force unknown to the astronomers, the eclipse seemed to exert some potent influence over the weather. At any rate, it was asserted by many of the rural papers that no rain could be expected until the eclipse was over. But if there was an absence of rain, there was no lack of clouds nor were the clear skies we had been led to expect afforded us. As the time for the eclipse drew nearer, the continued appearance of clouds began to cause anxiety among us. Would they interfere with the eclipse, and, at the last, make all the weeks of careful preparation of no account? If this had happened, it would not have been the first event of the kind. Unfortunately for the astronomer, his work is always at the mercy of the clouds and the weather. But to have the whole work

fail through the presence of clouds at the time of the few precious minutes of the total eclipse—that is indeed the keenest sort of disappointment! Some astronomers seem to be always unlucky and always experience cloudy weather on their eclipse expeditions, while, on the other hand, others are always lucky, and sometimes, after all hope is abandoned, a rift will appear in the clouds and the eclipse at totality be seen in all its glory. Would we at Baker be lucky or unlucky, would the clouds interfere or not? Nearly all the days spent in Baker, according to the classification of the United States Weather Bureau, were clear. But a "clear" day does not mean one when there is an entire absence of clouds. In fact, clouds gathered almost every day shortly after noon, and this condition was usually accompanied by very high winds, that at times rose to the strength of a mild gale. The eclipse was to occur during the middle of the afternoon, and at this time of day the skies were usually overcast. These same conditions prevailed over the whole of the western United States along the path where the astronomers were located. It was well to be an optimist under such conditions of sky, for the pessimist became more and more wretched as the day of the eclipse drew near and his law of averages showed him the almost certain chance of a thinly clouded sky during the total eclipse.

The writer of this article had so far been among the lucky astronomers. In 1900, at the first eclipse observed, the weather was ideal, not a single cloud in the whole sky. In 1901, he was a member of a rather large party which traveled halfway round the world. Only four of a total of thirteen saw the eclipse, the other nine witnessed the eclipse eclipsed by clouds. The writer was one of the fortunate four. Again in 1905, there were many clouds which spoiled the researches of many parties. At Daroca in Spain, a few minutes before totality a dense cloud covered the sun, but it cleared away before the all-important time, and the total phase was seen through a brilliantly clear sky. Three lucky chances out of three made a fine average. The hope was that June 8 would make it four out of four.

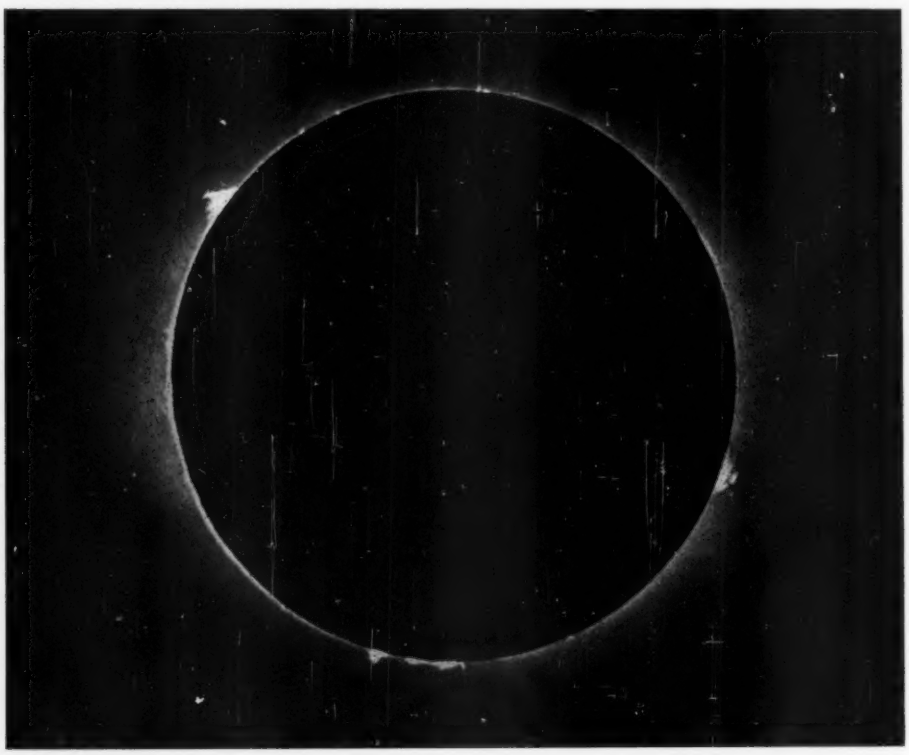
By May 30, the whole party had assembled in Baker. A full week was given up to the final adjustments, and to the drills that were to play such an essential part in the work on eclipse day. During the partial phases of the eclipse, very few observations of importance were to be made; all observations of value came during the period of totality which lasted for one hundred and twelve brief seconds. If a slide of a plate holder should stick in place so that it could not be removed, or a lens were not uncapped at the proper time so as to let in the light, the whole work of an instrument might come to naught. On each day of the week preceding June 8, drills were gone through several times in the morning and again in the afternoon. These drills were so well carried out that on eclipse day each and every one performed excellently the task allotted to him with the result that everything passed off without a single hitch.

As the days in June progressed toward the eighth, there was an air of excitement as each astronomer grew more keyed up to the task before him. Would the day be clear? But more especially, would the two minutes from 4:04 P.M. to 4:06 be clear on Saturday? The skies were anxiously watched during the last days, and almost every day the skies were overcast. The optimist reasoned that if it were cloudy all the days before June 8, then on eclipse day perfect weather would surely be forthcoming; while the pessimist reasoned that so many cloudy days meant still one more of the same character, so there was no use trying to do anything.

Saturday, June 8, dawned with the

sky overcast with thin, filmy clouds. The sun was well visible through these clouds, however, and it was possible to examine again the focus that had been obtained with the spectroscopes and with a touch here and a touch there to decide that everything was in perfect condition. During the morning the drills were again gone through with, and these seemed to promise success. The weather during the six weeks had not held up the work, and everything seemed now to have been done that thought and work could do. The astronomers who had been on the ground for the whole six weeks of preparation had the pleasant consciousness that all of their allotted tasks had been completed, that every little detail had been thought of, and that perfect success would certainly crown their efforts if the clouds would only clear away. But during the course of the morning the clouds grew thicker instead of thinner, and it did indeed seem as if there were little chance of clear skies.

The first contact was to take place at 2:36 P.M. Shortly after noon the city of Baker took upon itself the aspect of a holiday. Though the day was Saturday, all stores were closed from three until five in the afternoon so that everybody could have a chance to see the phenomenon. Naturally everyone in Baker wished to go to the eclipse site at the Fair Grounds to watch the astronomers at work. At the eclipse in Spain, this had been permitted with the result that the whole town was assembled, each inhabitant jostling his neighbor to get as close as possible. Unfortunately, each Spaniard seemed

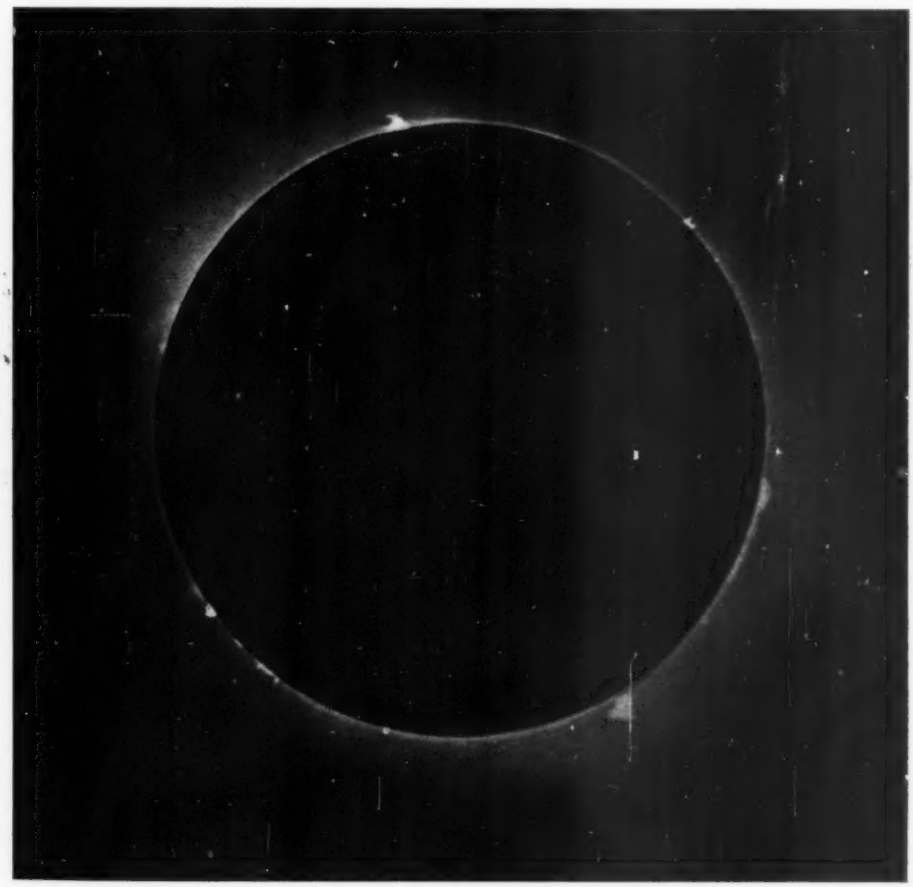


Photograph of the solar eclipse taken by a 40-foot camera with ⅓ second exposure at the Lick Observatory Station in Goldendale, Washington. The deep purplish blue shadow appearing over the sky was equally as dark as the black surface of the moon and was sufficiently heavy to bring out the brighter stars. The "Eagle Prominence" appears above and to the left

to be bent on telling his friend just what was being done, with the result that such a din arose when the eclipse became total that it was impossible to hear the seconds counted off to give warning to the astronomers when to change their plate holders.

That this might not happen again, the residents of Baker were told that the gates of the Fair Grounds would be closed, and absolutely no one would be admitted within the enclosure. The mayor of the city sent a guard of Boy Scouts to see that these orders were obeyed. Most of the town repaired to the hills to the southeast of the city from which there could be obtained a fine view of the valley and the Elkhorn Range, and they were directed to look especially for the shadow of the moon which would come across the landscape at the speed of about thirty miles a minute or 1800 miles an hour. This shadow comes with the advent of totality, and all who have seen the phenomenon say that it is an awe-inspiring spectacle, making one feel that the end of the world is surely at hand.

No appreciable improvement in the skies was observed from noon to the time of first contact. Through a thin patch in the clouds, Mr. Hammond,

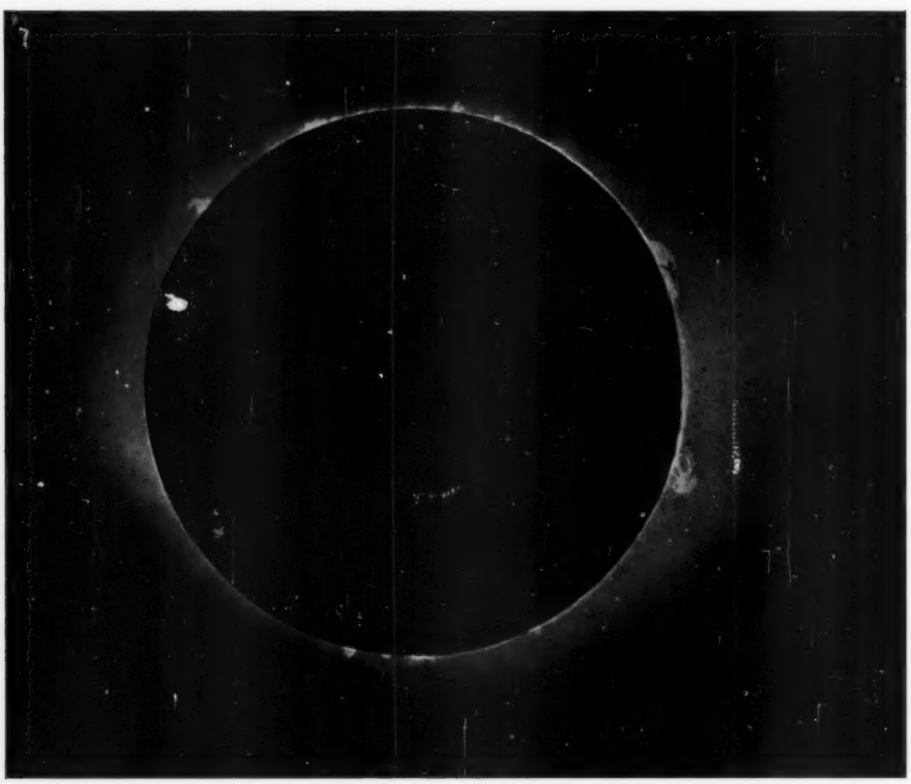


Total eclipse as photographed by the 65-foot camera at the United States Naval Observatory Station, Baker, Oregon. This solar photograph with many others are now on exhibition at the American Museum in the form of illuminated photographic transparencies. The "Eagle Prominence" appears at the top. The changed position of this prominence, compared with the photograph on the left hand page, is owing simply to the difference in position of plate holders in the two cameras

using the five-inch visual telescope, observed the beginning of the eclipse and made a record of it. The clouds, if anything, became thicker after this so that at three o'clock it was impossible to see even where the sun was. Little thin rifts appeared at times, so that with the aid of smoked glass it was possible to see the moon encroaching on the face of the sun. At three thirty, a patch of brilliantly blue sky was seen off to the northwest, and as the precious minutes dragged along it became evident that the clouds were moving in such a way that it was quite possible that the blue patch would reach the sun in time for totality. Fifteen minutes before the total phase, the clouds were so dense that had totality occurred then, the scientific results would have been nothing; but the blue sky was coming nearer and it might arrive in time.

Without looking at the sky, one realized that something unusual was happening. The light of the sun became so feeble that even the birds felt the unnatural aspect of things and sang their songs as if they were going to rest. The cocks crowed on the farm near by. The wind which was ordinarily blowing at this hour was quiet. All nature was hushed. Even the seasoned astronomers who had seen two or three eclipses before felt the thrill of the unusual spectacle. And still the question was, Would the clouds clear away in time?

At five minutes before totality the warning signal was given by Chief Petty Officer Welsch of the United



This photograph was taken during the last seven seconds of totality by the Lowell Observatory Station at Syracuse, Kansas. It shows the detail of the prominences and the great solar storm which was uncovered as the eclipse neared its end. A camera of 38 feet focal length was employed at this station. The "Eagle Prominence" is above and to the left

States Navy who was to watch the chronometer and count the seconds. This signal summoned each man to his post. One last look was given to the apparatus to see that everything was in place, the plate holders were adjusted—and then we waited. "Two minutes" before was called out, and then "one minute," still again "thirty seconds" before the expected time of totality. The clouds by this time had thinned considerably, the patch of blue sky was only a short distance away. The plan had been that after the signal of "thirty seconds" there should be nothing said until the word "Go" told that the total eclipse had begun. I was to watch for this with a pair of binoculars, before one glass of which a direct vision spectroscope had been arranged. But due to the thin clouds at the beginning, it was impossible to see the spectrum lines with the spectroscope, and the signal "Go" was actually given by Mr. Hammond who was using the five-inch telescope. No sounds disturbed the work of the party except the call of the seconds as the time passed, and the brief words of command and the shift of plate holders as each member of the party did his allotted task. Ten seconds after totality commenced, the clouds, thin at the beginning, had still further thinned, and at mid-totality the conditions were even further improved. What a gorgeous spectacle then met the eye! The sun was now in a very thin wisp of cloud with blue sky on either side. Although the cloud would detract from the scientific results, still it greatly enhanced the pictorial effect. The corona could be seen stretching for a short distance from the sun's edge, but most remarkable of all were three great tongues of flame, one immediately at the top of the sun, one on the left-hand edge, and still a larger one on the right edge of the sun. These shone with a brilliant scarlet light, and made the eclipse of 1918 memorable as the eclipse of color. As the end of totality approached the thin clouds became still thinner—and two minutes after the eclipse was over the sun had reached the blue patch of sky. If the eclipse had occurred only two minutes later, or if the party had been only half a mile to the northwest, the sky conditions would have been perfect! If the eclipse had taken place fifteen minutes earlier, the scientific results would have been nothing at all. The optimists had won out.

The developed photographs exhibit the painstaking care of the astronomers in procuring the precise focus with the result that all of the photographs show exquisite definition. The thin clouds did not interfere at all with the details of the prominences or flames surrounding the sun. Those taken with the sixty-five foot camera exhibit the prominences in splendid detail on a scale where the sun is more than seven inches in diameter. The longer exposures for procuring the extensions of the corona were not quite so successful since the thin, fleecy clouds cut down the fainter streams of coronal light. The smaller cameras showed the same results as the larger ones—splendid detail in the inner corona, but the corona not of very great extent. All the photographs unite in showing many polar rays, and they also exhibit some plumed arches of great beauty. The corona was of the sunspot maximum type, but with more polar streamers than were expected.

The spectroscopes procured photographs of exquisite definition, but these photographs suffered also from the clouds which cut down the amount of exposure that at best is none too great.

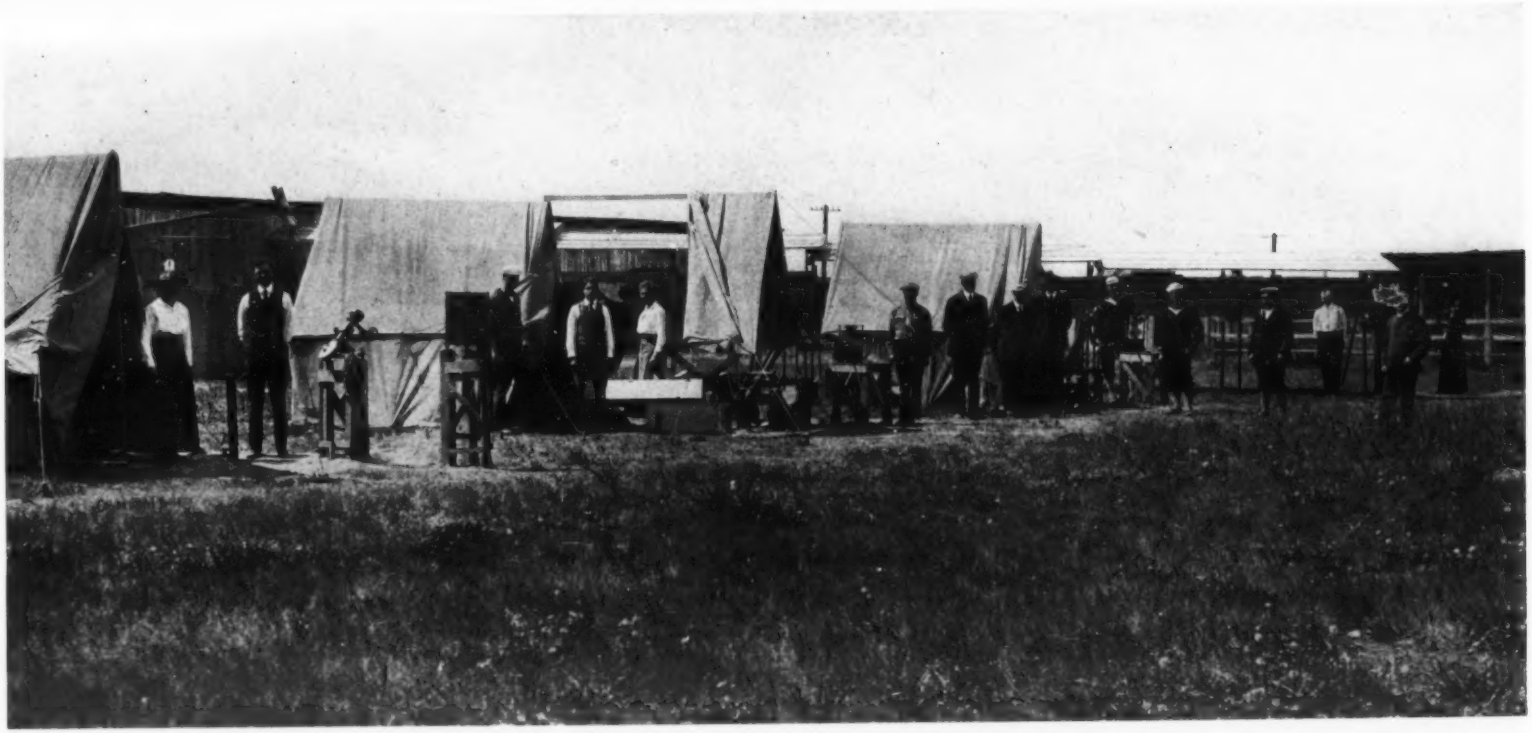
What was perhaps the most interesting piece of scientific work accomplished at the 1918 eclipse owes its conception to Mr. Edward D. Adams, of New York, who has shown his great interest in science by the founding of the Ernest Kempton Adams fellowship which is awarded each year by Columbia University for researches in the do-

main of pure science. Upon becoming a member of the United States Naval Observatory party, Mr. Adams took upon himself the responsibility of trying, by some method, by photography, by a drawing, or by a painting, to procure a reproduction which would show the beauties of the corona, and which should be true not only as to form but more especially as to color. Unfortunately for science, it is impossible to obtain a satisfactory representation of the corona and the sun's surroundings by photography. The corona is very brilliant near the edge of the sun, but the intensity fades very rapidly. The eye can take cognizance of the details in spite of the great changes in brilliance, but not so the photographic plate. To obtain the faint extensions of the corona which are readily visible to the naked eye, a comparatively long exposure is necessary. This long exposure causes so much overexposure in the brighter inner regions of the corona that all detail there is lost by being burnt out. Short exposures give us the inner corona in exquisite detail, but the outer corona is then lost through shortness of exposure. Many attempts have been made to cut down the relative exposure by means of mechanical devices —but none of these have been entirely successful. Heretofore, the only success in representing the corona has been obtained by taking photographs with different times of exposure and with different cameras in order to procure photographs with detail both in the inner and brighter parts of the corona, and in the fainter outlying portions. After the eclipse is over, a composite drawing is usually made from the examination of different photographs. This method has given several satisfactory drawings, but they still have left much to be desired. However perfect they may have been as drawings, they took no note of color. Mr. Adams took upon himself the task of finding the right man to draw and paint the corona. Color photography could not help out in procuring the right color, and there was left only the possibility of finding an artist who would have the true scientific spirit, and who could combine an accurate sense of form with a refined perception of color. Mr. Adams was successful in finding Mr. Howard Russell Butler, a portrait painter of note, who has developed a shorthand method of noting both form and color.

During the eclipse, Mr. Butler sat on a lofty perch overlooking the eclipse instruments, and from which he could obtain a fine view of the sun. The task he had taken to himself was no small one. And moreover this was the first corona he had ever seen!

Those who were privileged to see Mr. Butler's picture at the American Museum of Natural History pronounced it a painting of rare beauty. The astronomers who saw the 1918 eclipse and who have seen the picture look upon it as a marvel of perfection, true both as to form and color, a work of art which has the added advantage of being scientifically accurate.

The scientific world owes a great debt of gratitude to Mr. Butler for his exquisite corona, but even a still greater debt to Mr. Adams, through whose conception, generosity, and enthusiasm the painting of the corona became possible. One ventures to predict that this splendid painting will cause the recent total eclipse of the sun to be known as "Color Eclipse of 1918."



INSTRUMENTS ADJUSTED AND EVERYBODY READY, UNITED STATES NAVAL OBSERVATORY STATION, BAKER, OREGON

The first two tents cover powerful spectroscopes and under the third are two cameras. The horizontal tube of the 65-foot camera is seen in the background. Five of the party started work at Baker just six weeks before the eclipse, mounting, testing and adjusting the apparatus, determining the exact geographical position of the site by direct telegraphic comparison of time with Washington, and constructing the housing for a camera of 65 feet focal length. Five sailors (mechanics and carpenters) under a chief petty officer, were also detailed from the Naval Station at Bremerton, Washington, to assist the astronomers in their work of preparation. The most important feature for a government eclipse expedition to determine is the exact time of contact of the sun and moon in order to determine the moon's exact position and make corrections in the *Nautical Almanac* which is used by navigators and geodesists. The movement of the moon is extremely complicated so that errors of several seconds are sometimes made in calculating its position. Another important piece of work is the photographing of the bright line spectrum of the inner layers of the sun's atmosphere. This is possible only for a few seconds at the beginning and end of totality when the moon has just covered the brilliant face of the sun but has not yet passed over the lower atmosphere of incandescent gases.

The members of the observing party, naming from left to right, are as follows: Dr. Mary M. Hopkins, associate professor of astronomy, Smith College; Dr. S. A. Mitchell, director, McCormick Observatory, University of Virginia; Pehling, sailor, United States Navy; Dr. P. W. Merrill, Bureau of Standards, Washington; Dr. Harriet W. Bigelow, director of observatory, Smith College; Dr. L. G. Hoxton, professor of physics, University of Virginia; Messrs. J. C. Hammond, astronomer, G. H. Peters, photographer, and C. C. Wylie, assistant, United States Naval Observatory; Herrick and Kummel, sailors, United States Navy; P. Welsch, C. P. O., United States Navy; Mr. W. A. Conrad, assistant, United States Naval Observatory; Mr. Howard Russell Butler, N. A.

Painting the Solar Corona

By HOWARD RUSSELL BUTLER, N.A.

Illustrations from drawings which give the artist's records made at the time of the eclipse and explain his method of work; also from the artist's paintings of the phenomena of the eclipse, color plate opposite, and frontispiece in color "Total Eclipse of the Sun, June 8, 1918," opposite page 245

IN May, 1918, I received an invitation from Mr. Edward D. Adams, well known as a patron of science and art, to accompany him to Baker, Oregon, where the United States Naval Observatory had established its station for observing the total solar eclipse of June 8, 1918. Professor S. A. Mitchell, director of the Leander McCormick Observatory of the University of Virginia, and Mr. Adams had agreed that a painting of the corona might be made which would have both scientific and artistic interest.

Many drawings and countless photographs (some colored by hand) have been made of solar coronas, but I was told that no record existed of any painting actually made from direct observation. The invitation was therefore accepted as a unique opportunity.

As a portrait painter I have usually asked for ten or twelve sittings of two hours each: now I was asked to render my subject in 112 seconds. The method of procedure therefore became all-important.

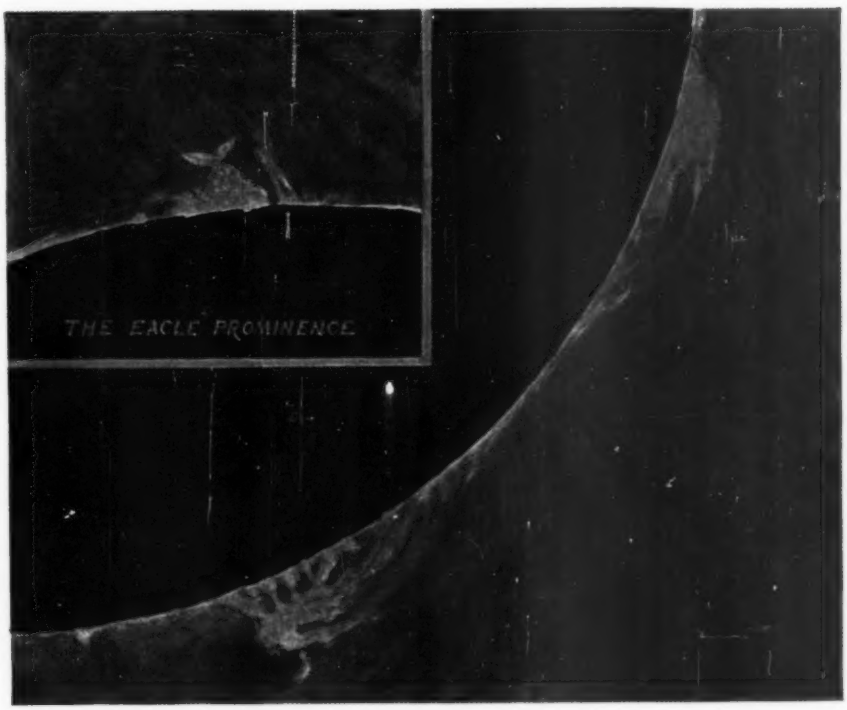
The first step was to study the reports in astronomical and popular works of previous eclipses and thus familiarize myself with all attempts to describe or record the form and color of the corona and prominences. Of these attempts there are a great number. They describe an outer corona, varying in extension from a fraction of a diameter of the moon to many diameters, the color usually being described as pearly and variously tinged; an inner corona, more brilliant than the former; and the prominences of incandescent hydrogen, variously described as red, ruby colored, pink, and blood-red. In addition to these, my picture would have to show the dark surface of the moon, and the sky with whatever color value it chanced to have at the moment of observation.

As regards the shape and the extension of the outer corona, a theory exists that it varies inversely in size as the combined area of sun spots, and this seemed to be confirmed by about twenty drawings of previous eclipses, which I made from photographs and prints and reduced to the same scale. Thus in the eclipse of 1900, when sun spots were at a minimum, the corona exhibited wide extensions, having interesting shapes, two of which became known as the "Angel Wing" and the "Herring Tail" extensions. As the number and size of sun spots seem to vary quite regularly, so that the maximum is reached about every eleven years, and as we were near a maximum period, wide extensions of the outer corona were not to be looked for. We expected about three fourths of a diameter on each side and this is about what we saw.

All reports of the so-called "inner corona" agree that the part nearest to the sun is very brilliant and this inner corona is usually described as whitish in color. The transition from this inner portion to the far less brilliant outer part is quite abrupt, but one of the questions on which there seems to be a difference of opinion concerns an absolute demarcation between the inner and the outer coronas. I found none.

As regards the prominences—while often discernible with the naked eye, it

The approaching shadow of the moon, Baker, Oregon, June 8, 1918



Details of the hydrogen prominences, June 8, 1918, including the "Eagle Prominence." In outline this prominence looks like an eagle alighting on the top of a cliff.

is necessary to have a good glass to get the details of shape and to study the color rightly. The Naval Observatory put at my disposal a fine pair of Zeiss binoculars, which proved of the greatest value. I realized in advance that my hardest task would be to portray these prominences in their proper color and brilliancy. According to Professor Mitchell, I was to expect them to have a color not unlike that of the hydrogen line H*a* in the spectrum, possibly slightly modified by the much fainter bluish line; and ample opportunity to study these lines in the spectroscope was given to me. How best to render this color in paint and to give it its luminous character was the problem. Realizing that this would necessarily be the brightest tone in the picture and that it would have to stand out brilliantly against the tone of the inner corona, also bright, I set to work to produce the brightest possible red; that is, the one which stood highest in a scale of values of which varnished ivory black was zero and the best lead white (commercially known as silver white) was 100. I tried French pastels and water colors, the latter over Whatman paper, but ultimately found that I could do best with oil paint.

The process of obtaining this red decided upon for the final picture, but which takes more time than I had at Baker, was to prepare a hard surface of silver white, well dried, to paint over that a thin coating of zinc white tinged with orange cadmium, and, when that was perfectly dry, to glaze it richly with rose madder or garance rose doré. This gave the tone with its fiery quality, but alas, its value, while the highest that I could get, was down to from 65 to 70 in the black and white scale. The highest value obtained by mixing wet colors at Baker was about 60.

Granting this to be the highest note that I could have in my picture, I next addressed myself to the lowest. Would this be the sky or the dark surface of the moon? Regarding the color and value of the clear sky during solar eclipses, there were varying opinions. Many drawings show the moon as black against a sky represented by a medium gray. These I believed to be incorrect and found them so. The moon, having a less luminous quality than the sky and surrounded by the brilliancy of the corona, should appear slightly darker by optical illusion. The sky value was at any rate the safer note to work from and, except for the slight variation alluded to in the moon, it would surely be the darkest value in the picture.

Assuming then a sky value of say 25 and a prominence red value of say 60, the total variation in values would thus be limited to 35 points—surely a small range with which to reproduce so brilliant a phenomenon.

The method of working finally adopted may be called a shorthand method. It was to have a sheet of white cardboard on the easel with a series of concentric circles and radii drawn upon it in advance. One of these circles was to have the same diameter as the photographs of the moon to be taken in the sixty-five-foot camera, namely, seven and three-eighths inches. There was to be an inner circle of half this diameter and outer circles whose diameters were respectively one and one half, two, and two and one half times that of the inner circle. I expected to use the seven and three-eighths inch diameter, and did actually use it, but I was thus prepared, in case of an unexpectedly extended corona, to reduce the scale to one half and get everything on the cardboard. In front and beneath my cardboard was a finished sample picture of a corona, painted in advance as I *expected* it would appear, and my plan was to indicate by initials at points on my cardboard the variations of color from this picture; thus *b* was to mean a variation toward blue from the sample picture,

and *y* more toward yellow. I wrote out the procedure as follows and tacked it alongside the easel. Practice enabled me to allot a certain number of seconds to each item.

Procedure	*Seconds*
Note value and color of sky	10
Draw value line on moon	10
Note colors of moon	10
Draw outline of corona	20
Use Zeiss binoculars	20
Record positions of prominences	10
Note color and value of prominences	10
Note colors and values of corona, etc.	20
	110

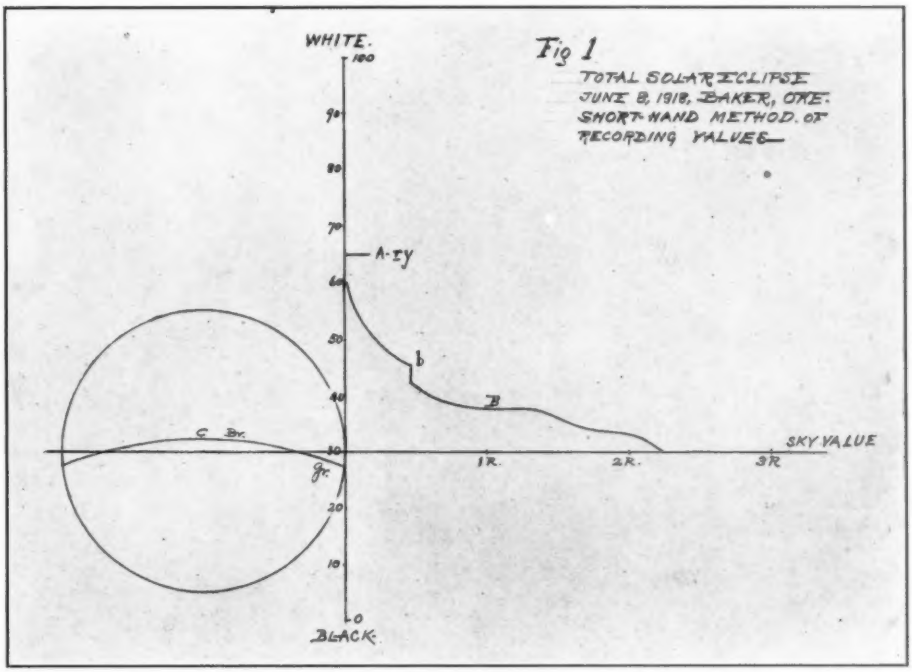
Then my plan was to paint a first picture from this resulting memorandum, while the impression was vivid, and as soon as there was sufficient light to proceed by.

Several methods of still further shortening the process naturally presented themselves, which can best be understood by a simple diagram. Thus let the vertical axis (Fig. 1) represent values in the black and white scale and the horizontal axis distances in terms of lunar radii. Then a simple stroke *A* at 65 gives the value of the prominence, and the added expression *ry* means "rose very strong with a tinge of yellow." The line *B* represents the values of the corona. Any distinction between an inner and outer corona could be noted by a quick fall, as at *b*, in the line. Two tangents were drawn in advance on my cardboard for use as vertical axes. The line *C* would show the moon to be light in the center and dark on the edges, in this case tinged with green and brown. After the actual experience, I cannot think of a better plan than this one.

The observation station was in the Fair Grounds at Baker, about a mile and a half from the center of the town. It was surrounded by a wall and low buildings, which insured privacy. A grand stand ran north and south with a double door opening from the top aisle. This door, intended as an exit or fire escape, opened upon a platform with flights of steps descending both ways. This platform was assigned to me and on it I erected a strong easel and shelves extending to right and left and making an angle with each other. Wind guards and braces were added. The platform faced west and, as the sun at the time of the eclipse was to be about 12° south of west, the position could not have been better. It had also a great advantage in being so high up that I could look over the surrounding walls and low buildings and get a fine view of the valley and of the Elk Horn Range in the direction of northwest along the line of the approaching shadow. By keeping the north half of the door into the grand stand closed and boring a small hole through the door, an excellent camera obscura was obtained, the image of the sun appearing on a tilted white covered board on the inner side of the door. I had been advised and had determined not to look at the sun for a considerable time before totality so as to avoid what is known as retina-fatigue, which is certain to result from looking at the brilliant crescent. The camera obscura gave all the information wanted as to the diminishing crescent and yet left me free to watch for the approaching shadow.

As the day drew near drills were instituted, eight or ten of which I attended; each time I went through the procedure as outlined, drawing an imaginary eclipse. The counter, a naval officer, called each minute from five before to one before, and then gave the call, "thirty seconds." The word "go" was given by Mr. J. C. Hammond, astronomer of the Naval Observatory. (On the occasion itself this word was given, of course, from actual observation of the eclipse.) The counter then called seconds from 1 to 112, when the performance would supposedly be over. These drills were invaluable.

At first contact, June 8, 2.47 P.M., all was ready, but the sky was so cloudy

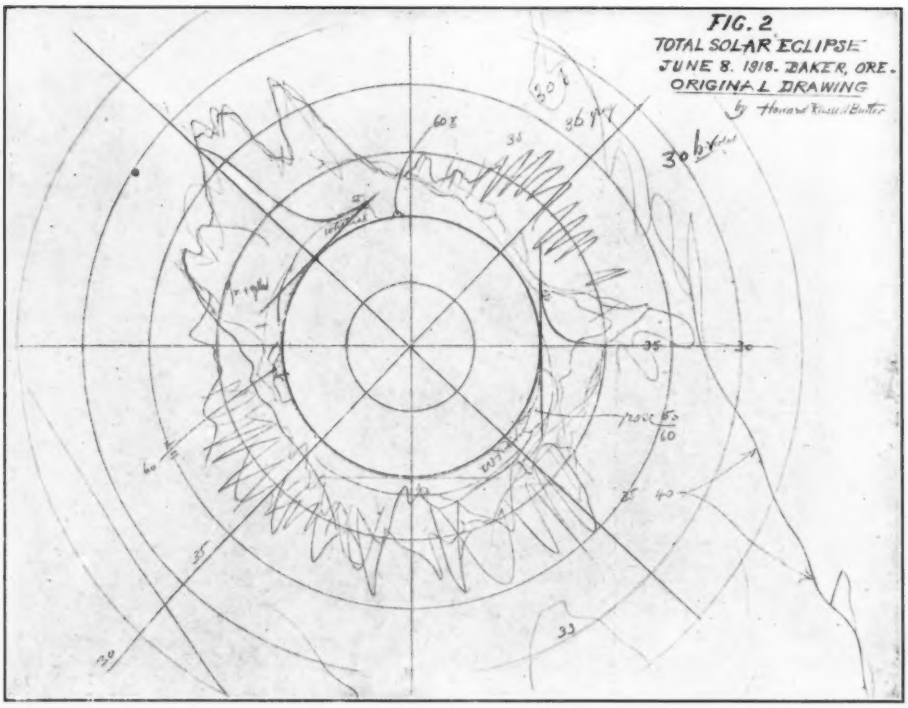


Two diagrams combined, one illustrating the artist's shorthand method of recording during the few seconds of the eclipse the brightness of the colors in the corona, the other a method of noting the depth of shadow on different areas of the moon's disk. One diagram consists of the two perpendicular lines, or axes, and the curve B. The vertical axis represents a scale for measuring the brightness of a color, considering ivory black as zero and silver white as 100. Distance on the horizontal axis measures distance on the sky beyond the moon's edge measured in radii of the moon ("1R" equals a distance of one radius or half the moon's diameter from the moon's edge). This horizontal axis is drawn through 30 on the brightness scale, that being the estimated brightness value of the sky during the eclipse. A curve drawn between the axes shows the variation in brightness of the corona at any given point, beginning at the inner edge of the corona and passing outward to the dark sky; that is, the color in the inner corona close to the moon is 60 on the scale (or in other words the tone of the inner corona is about three fifths as bright as silver white). From the curve drawn downward from 60 we see that the corona at 1R (one radius distant from the moon's edge) had fallen to a brightness of about 40, and slightly beyond the length of 2R it disappears, blending with the sky. The line A is the artist's shorthand to indicate that the prominences had a brightness value of 65 and "Ivy" is a quick way of recording it if they were "very rosy, tinged with yellow." These two axes were drawn on the cardboards on which the eclipse was to be drawn, in advance, on two sides of the circle of the moon (see Figure 2), being represented as tangents to the moon's circle (see right hand and upper left hand of figure). By means of the curves drawn in on these axes with great speed during the eclipse, we can read off the brightness of the corona's colors at any distance from the moon.

The line C in the other diagram (the moon's disk at the left) is a shorthand way of indicating that the moon was lighter in the center than at the edges and that these edges were darker than the sky. The "Br." and "Gr." indicate a tinge of brown and green respectively

that few of the eighteen members of the party expected any good results. A gloom more dense than the cloud overhung the spirits of the camp. But at half past three the clouds had grown decidedly thinner, and at ten minutes of four a large area of blue sky appeared to the right of the sun. Then the sky cleared so rapidly that all hopes were revived, in the belief that when totality would take place at 4.03.52 the sun would be found in an absolutely clear sky.

Standing with the sun back over my left shoulder—it was at an elevation of about 45°—I looked at the diminishing crescent on the face of the camera obscura until the call "one minute" was heard. Then, turning my eyes to the northwest, I gazed at the north end of



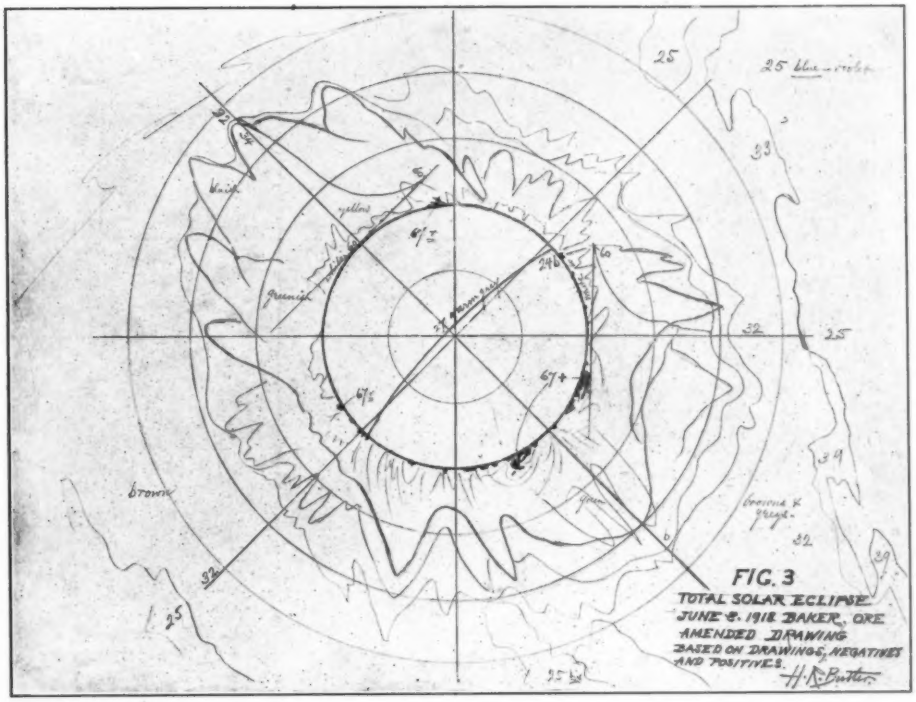
This is a reproduction of the actual original sketch, made at the time of the eclipse, on a cardboard on which the radial lines, circles, and tangents had been prepared in advance. This is the artist's record, not only of the general outlines of clouds and corona, but also of the colors which are indicated by initials or words (underscored when the color is intense), and of the brightness of the various parts of the corona, indicated by numbers and by curves such as are explained in the preceding figure. The artist had painted previously a picture of the way in which he "expected" the eclipse to appear and no time was wasted putting in colors or tones which were approximately correct in the prepared sketch

the Elk Horn Range and the intervening valley. Roosters were crowing loudly on the neighboring farm; a greenish pallor overspread the landscape—but it was not very dark. To the northwest, however, the sky was growing dark. The last half minute seemed long. My eyes were fixed on the sky line. Suddenly the entire range fell to a deep low-valued blue, and simultaneously the lower part of the sky above the range turned to a rich yellow inclining to orange streaked with two horizontal blue-gray clouds. Above me the sky darkened rapidly. For an instant the valley retained its light green color and then the shadow seemed to rush toward us and all was engulfed as the call "Go" was shouted.

The accompanying color illustration of the approaching moon shadow (opposite page 264) is from a "memory" painting made the next day, the time ten seconds before totality.

Turning on my heel, I looked at the corona, blazing steadily in the heavens as if it had always been there. The clear space in the sky had not quite reached the sun. The thin intervening cloud extended to right and left of the sun and stood out with its edges illuminated and sharply defined against a velvety night sky of wonderful bluish violet.

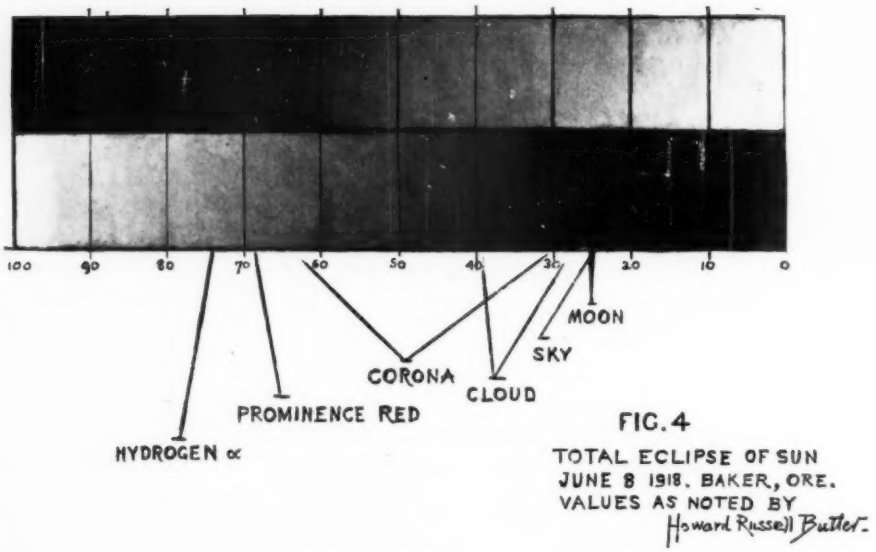
Here was a new problem. I had not expected the cloud. I began by drawing the outline of the cloud (slightly nearer the sun than it actually was so as to get both cloud and sky well on the



The artist's original drawing as amended later by reference to photographs made of the corona. The details of the polar rays and of the prominences had been left for the cameras to record. Careful drawings of these features and of the variations in shading of the corona resulted in this composite picture on which was based the painting of the corona (see plate opposite page 245). The lines outlining the corona in this figure may be regarded as contours of luminosity, showing the range and extent of certain degrees of brilliancy around the disk

cardboard), then entered the value and color of the sky as 30 *bv*, and the cloud edges which were higher and silvery. The cloud itself, of varying thicknesses, was warmer in tone than the sky and played, I estimated, between 30 and 40. The moon was about the same value and much grayer than the sky. I was not conscious of any considerable variations of value in the moon and failed to put in the value line. The blackishness of the moon and the center lighter than the edges were undoubtedly optical illusions. Next a quick outline of the corona was made, most attention being paid to the larger rays. Then the binoculars (which had been previously adjusted and focused) were used. Two splendid prominences, slightly pinker and lighter than I had expected, appeared—one near the top of the sun and the other on the left side below the horizontal. I gave these the highest value which I then thought could be produced by mixing oil paints, *viz.*, 60*r*. A rose-colored glow stretched along the lower right side of the limb, the value of which was first recorded on the chart as 50.

I recorded two lines of values for the outer corona. I saw no distinct separation of the inner and outer coronas. On the upper left extension greenish and yellowish tones were recorded. No time was wasted on tones thought to be correct in the sample picture. On the whole the corona was less blue than my sample and it retained brilliancy farther out than I expected. Had it been seen against the blue sky it probably would have extended still farther and its disappear-



A graphic representation of the scale of brightness values of the various colors found in the eclipse phenomena.—Varnished ivory black is taken as zero and the best white lead (silver white) as 100 for the points of reference. The most brilliant shades were found in the prominences which consist for the most part of incandescent hydrogen gas with a color approaching that of the red hydrogen line of the spectrum. By careful painting the brightness of the reds used in portraying the prominences was forced up to 67, and a very fiery quality given to them. The brightness of the sky was pitched at 25, as was the moon, while it was estimated that the clouds ranged from 30 to 40, and the corona from about 30 to 60

ance might have been more gradual. Two sections of the so-called inner corona were very brilliant, although of course not as high in value as the prominences. These were next to the limb and were very neutral as to color. I outlined them and marked them "whitish," but got one of them in the wrong place. This brought my eyes to the picture for several seconds. About the ninety-fifth second I looked up and was surprised to see that the pink glow had lengthened out and risen in value. This change was due to the motion of the moon, which had by that time uncovered a magnificent solar eruption, but I had no time to take up the glasses. I outlined this glow, its value fully up to 60, which I entered afterward. Figure 2 is a reproduction of the original drawing.

Toward the end I re-outlined the corona, indicating rapidly the polar rays, for the accurate drawing of which, as well as for that of the prominences, I intended to rely on the photographs. These rays were decidedly apparent. Suddenly I was blinded by the first of the "Baily's Beads," or the first glimpse of the solar crescent broken by the rough limb of the moon. It looked like a miniature sun radiating in all directions. And all was over.

Thanks to the privacy of the grounds and the consideration shown me I was able to proceed at once with my first oil sketch, and for two hours worked uninterruptedly. The next day, June 9, I painted the picture of the approaching moon shadow over the Elk Horn Range as I remembered it and also a second oil of the corona.

While disappointed in not seeing the corona in a cloudless sky, the thin veil had its advantage from the artist's standpoint. It added mystery and the effect was picturesque. The brilliant corona burned through the thin veil as if it were not there. Probably only the

outside edges of the corona were affected.

On the tenth the photographic negatives were shown to me. Those of the sixty-five-foot camera were seven and three eighths inches in diameter, the others considerably smaller. I now saw, in minute detail, the two prominences which I had recorded and the mighty cyclone which had been increasingly revealed as the eclipse neared its end, because of the direction of the moon's motion. We are told that this group of prominences was forty-six thousand miles high. There were many other minor prominences.

I now made careful drawings of these prominences from the negatives and of the variations in shading of the surrounding corona. Many arches were found springing over the prominences, and a few rifts or dark channels radiating from the limb but never coming very close to it. The negatives showed very clearly the hairy polar rays, not always radial in direction, and the beginning of a wing springing from the upper right-hand limb of the sun.

By careful process painting, as already described, I have been able to force up the value of the prominence reds, which appear in Figures 3 and 4 at about 67. I also concluded to reduce the value of the clear sky from 30 to 25, thus obtaining a range of 42 points instead of 30, an increase in the ratio of 7 to 5. In this new scale the other values take their proportional places. Thus a value of 35 (30 + 5) in Figure 1 becomes 32 (25 + 7) in Figure 3.

In Figure 3 the corona lines, derived from the drawing and many photographs, may be regarded as a sort of composite, suggesting contours of luminosity very much as contours of elevation appear on a map.

Three paintings were made, the first immediately after the eclipse, the second on the succeeding day, and the third after all data had been secured. This final painting is the one reproduced in conjunction with this article.

Returning with Professor Mitchell, we stopped at Williams Bay, Wisconsin, and I had the great pleasure and advantage of discussing the problems of the final picture with Professor E. E. Barnard and Dr. E. B. Frost, of the Yerkes Observatory. They also showed me excellent photographs taken at one of the Yerkes stations and spectroscopic photographs of the prominences taken at the Yerkes Observatory (at the time of totality at the Green River Station), apparently identical as to drawing with those taken at the Baker Station. I wish to acknowledge my indebtedness to these eminent astronomers.

Photograph by Donald B. MacMillan

WILD FLOWERS "FROM GREENLAND'S ICY MOUNTAIN"

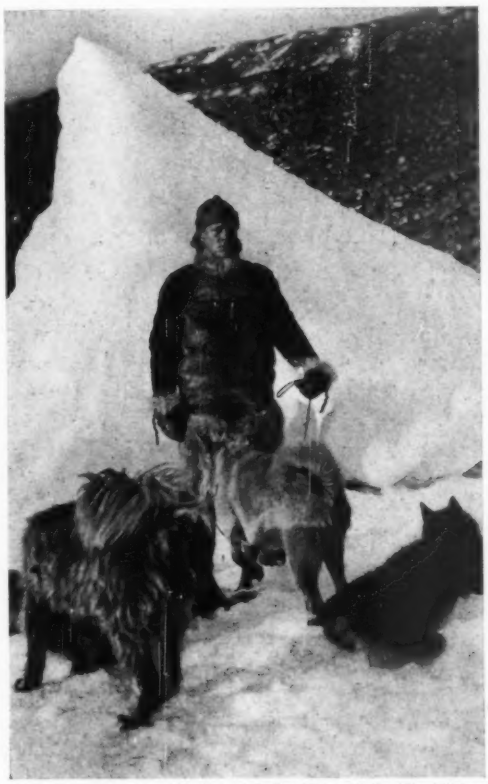
Between lonely rocks and wild crags grow the flower gardens of the Arctic—poppies with nodding buds and ornamental leaves, the small white clustered *Draba* flowers, and green heads of Arctic timothy. There are about 120 species of flowering plants—and probably "new" species waiting to be discovered—in the ice-free land where the Smith Sound Eskimos live, along the northwestern coast of Greenland between Humboldt Glacier on the north and Melville Bay on the south—a strip made narrow by the ice cap above and the iceberg-studded sound below. Long months pass when the botanist has few specimens to work with, however. Not until the ice breaks out and midsummer is at hand are many flowers in bloom. There is no spring in the Arctic like ours, or rather, there is only our spring, and no summer. All the plants awake together and hasten to their fruitage as if to make the most of the few weeks of comparative warmth. With equal suddenness at the end of summer, the vegetation is caught in full activity, and stiffened as it stands, with seeds half formed, or perhaps with buds, or open flowers

The Plant Life of Northwest Greenland

By W. ELMER EKBLAW

Research Associate, American Museum of Natural History; Research Fellow in Geology, University of Illinois; and Geologist and Botanist on the Crocker Land Expedition, 1913–1917

FEW people of our pleasant southland even dream that under the shadow of the North Pole, almost a thousand miles within the Arctic circle, more than one hundred species of flowering plants flourish and maintain themselves against the frigid conditions of their far northern home. Yet, in the country of the Smith Sound Eskimo, a narrow belt of ice-free land between the gleaming ice cap and the iceberg-studded sound, from Cape York to Humboldt Glacier, botanists have already recorded 120 species, and the list is no doubt yet incomplete. No tall trees or branching shrubs, no trailing vines or waist-high grasses give character to the landscape, but the rocky slopes and ledges are dotted in summer with brilliant blossoms or carpeted with low, soft growths of grass or sedge.



Photograph by Donald B. MacMillan

The botanist of the Crocker Land Expedition at North Star Bay

When the explorer from the southland approaches the rock-bound, glacier-ribboned coasts of Greenland, his first impression is one of bleakness and barrenness. The frowning cliffs, stern and unchangeable, the gleaming glaciers, cold and immobile, suggest no possible refuge for flowers, no likely niche for ferns or grasses. But in summer when he enters some little bay, or goes up one of the deep fiords and sets his foot upon the land, he finds that Greenland is not so cold, nor so bleak, nor so barren as he imagined. Every little crevice in the rocks is foothold for some fern or glowing flower, every little pocket of soil refuge for a bit of verdant turf, and every little slope or ledge shelter for willow, heather, or smiling poppy.

How can they grow and blossom and fruit in the short summer, when the snow begins to disappear only in mid-June, and killing frosts come in mid-August; when the warmest noonday has never a temperature higher than sixty degrees and storms often blanket the whole land with snow, even in mid-July? It is because the plants that hold their homes under these rigorous conditions are adapted to make the most of the twenty-four hour sunlight that shines

upon them, to survive the blanket of snow if it last not too long. They are the frontiersmen of the plant world, hardy, inured to difficult conditions, tenacious of life in the most desperate struggles for existence.

The climate of northwest Greenland is insular in character, much milder than most lands so far north, and than many lands much farther south, because the strong tides and currents in Smith Sound keep open water along the shore, or not far away, usually throughout the year; and open water means warmer, moister air. This milder, moister climate of northwest Greenland is naturally the principal reason why the vegetation is relatively so luxuriant; but the reason the flowering plants succeed so well is because in addition, during the short summer season, the sun shines every day all of the twenty-four hours, and gives them opportunity to use every hour of their active life.

Yet, even with this favorable milder climate and the continuous sunlight, the vegetation could not survive if it were not fitted to endure the long frozen period, cold and dry, the destructive changes from warmth to almost blighting cold. In response to these conditions the plants are usually low creeping or tufted forms with tough, hard tissue, and are nearly all perennials, so that if fruiting cannot take place every year the species will not perish.

Some of the plants that constitute the vegetation of northwest Greenland are widely and generally distributed. It would be hard to find a place where the purple saxifrage (*Saxifraga oppositifolia*) does not grow or the Arctic poppy (*Papaver radicatum*) does not flourish. The alpine chickweed of the north (*Cerastium alpinum*) and the Kentucky blue grass (*Poa pratensis*) are common. The pretty little Arctic heather (*Cassiope tetragona*) and the mountain avens (*Dryas integrifolia*) are perhaps the most numerous of the plants of the region, for they seem to be able to grow almost everywhere. Many others occur all along the coast and one expects to see them wherever one lands.

But many plants are found widely scattered. Of several species I found a single station or collecting place. *Androsace septentrionalis,* a delicate, inconspicuous little flower, never before recorded from Greenland, I found growing on a little gravel slope just west of Borup Lodge, our headquarters house. In 1898 my good friend, Simmons, the noted Swedish botanist, when traveling along this coast with Sverdrup's expedition, visited the delta on which, later (1913), our house was built, and must have passed over the very path beside which I found this little plant, and also a beautiful, luxuriantly growing fern, *Dryopteris fragrans.* That these two plants eluded his careful, critical search, illustrates how easily even a specialist may fail to notice some of the small plants of the Far North.

As a further illustration of how a plant may escape discovery, I like to cite my own experience at North Star Bay. Throughout the summer of 1914 I lived at the little mission station there, studying carefully the vegetation of the large area of ice-free land that lies about Wolstenholm Sound. Only a few feet from the front door of the station lies a small bog, in which I collected numerous plants, and helped my good colleague, Dr. M. C. Tanquary, to collect insects and plankton. Throughout the summer I thought I observed carefully every plant that grew in the bog, yet in 1916, when I again spent the summer at North Star Bay, I found there, growing in profusion, and in full bloom, the little red-stemmed, red-leaved *Montia lamprospermum,* which I had eagerly sought in 1914 without success.

In passing, I may state that nowhere in the region did I find so satisfactory

Photograph by E. O. Hovey

OPPORTUNITY FOR STUDY OF PLANT ECOLOGY IN THE ARCTIC

In the North—just as in regions farther south—plants of certain different kinds grow always associated with one another, and these definite associations may be isolated in zones. This life association of plants is easily studied in the Far North because species are few in number and there is no competition from lack of space. The photograph shows an association of water-loving plants grouped in three zones: floating far out in the water, in an "outer zone," are two members of the buttercup family (*Ranunculus hyperboreus* and *Ranunculus pauciatamineus*); rooted nearer the shore, in a "middle zone," is mare's tail (*Hippuris vulgaris*); and on the moist shore itself grows an "inner zone" made up of the conspicuous white cotton grass (*Eriophorum Scheuchzeri*) and a third species of the buttercup family (*Ranunculus sulfureus*).

Such pools are the residuum of the melting snows and may never wholly evaporate because of the quick return of freezing temperatures. The scene is at North Star Bay. Saunders Island, where great numbers of eider ducks nest, is visible in the background at the left

a place to study the plants as at North Star Bay. Within half a mile of the station I found eighty plants; the habitats are so varied, and the general conditions so favorable, that it is a botanist's paradise. It is also a splendid place in which to make a careful study of the much-worked-over and much-discussed *Drabæ,* for I think almost every northern form of this genus is found there in abundance, and in confusing variation.

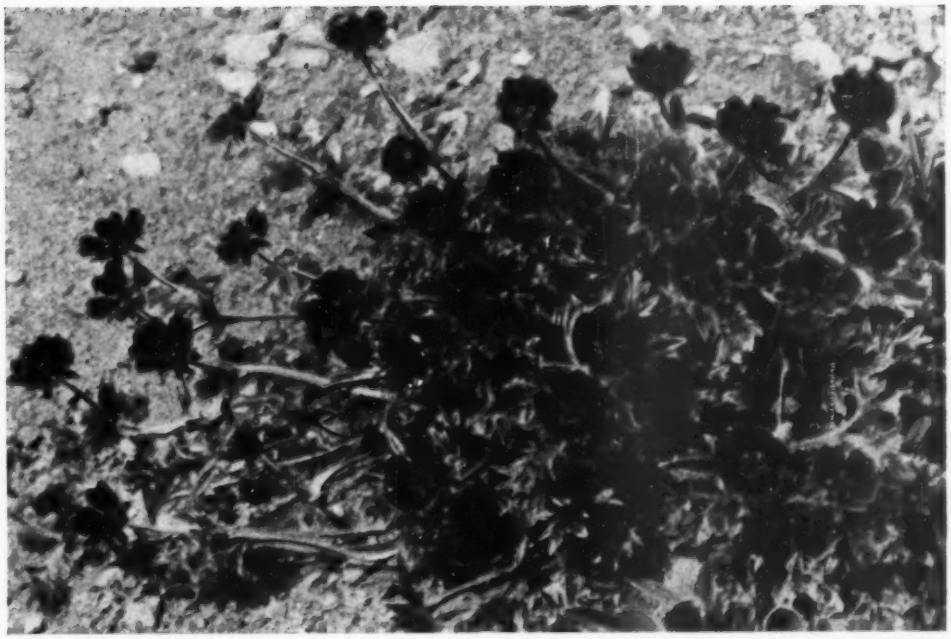
The study of plant association and plant societies in this region is fascinating. A slight change in the quantity of some one factor,—it may be one of the primary components of the habitats, or one of the secondary,—produces a change in the vegetation that is all the more easily recognized because of the simplicity of the association or the society. The struggle for survival in the North is not one so much of competition between the plants for light or food, as it is one against the climatic conditions. Generally speaking, there is no crowding of individual plants as there is in regions of denser vegetation. Light and room enough there are for all that can withstand and survive the stern climatic conditions.

Photograph by Donald B. MacMillan

The yellow flowers of the Greenland arnica (*Arnica alpina*) look like small sunflowers of temperate climes, but they are lowly in stature like all other Arctic flowers.

In the lower right-hand corner of the photograph appear a few glossy, oval leaves of the Arctic willow (*Salix arctica*). This most common and tallest of the "trees" of Greenland never attains a height of more than three inches, although its branches may spread over several square feet of ground. Stems of Arctic willows more than fifty years old, as proved by the number of their rings of wood, may be no thicker than a man's thumb. Another willow species (*Salix herbacea*) must be the smallest tree of the world. It grows one inch tall and has two leaves and one tiny furry catkin each summer. The botanist in Greenland finds many interesting plant problems for his consideration, especially that of distribution

Among the groups of plants that may be readily distinguished are the luxuriant grasses (*Alopecurus, Poa,* etc.), and the scurvy grass (*Cochlearia officinalis*), association of the cliffs and slopes where the numerous Arctic birds nest; the sedge (*Carex*) and the cotton grass (*Eriophorum polystachium*), association of seepage-water swales; and the heathlike association, on warm, airy, sunny slopes, of cat's-paw (*Antennaria alpina*), arnica (*Arnica alpina*), and reed-bent grass (*Calamagrostis*). Many other similar distinctive groups help to form as interesting a vegetation as one finds anywhere, even although the number of species is not so large,



Photograph by Donald B. MacMillan

Cheery cinquefoils with saffron-centered flowers measuring an inch wide (*Potentilla Vahliana*), relatives of the roses, sometimes cover and beautify whole acres of dry Arctic slope. To make so astonishing a showing of flowers in the short two months of summer, even with perennial stems and the protected position of the plants closely hugging the ground, there must be a minimum of interruption from summer snowstorms and frosts. The Crocker Land Expedition found a half dozen species of cinquefoils at the North, all with yellow flowers. The plant known in the North as "scurvy grass" (*Cochlearia officinalis*) belongs to the cress family (a family represented by sixteen species in northwestern Greenland). It is used as a preventive for a disease which has brought death to the ranks of so many Arctic expeditions. The Eskimos also sometimes eat the *Cochlearia* as a sort of salad, a pleasant variation from their meat diet

and the interrelationships not so complex as in that of more favored lands.

Of northwest Greenland it can hardly be said that one cannot see the forest for the trees. The tallest tree does not rise more than three inches from the ground; the view, then, is not appreciably obstructed by the forests. This tallest tree is the Arctic willow (*Salix arctica*), and it is the commonest. Although it grows so low, it often spreads over about a square yard or more of ground. Some of these trees, of which the trunk is not thicker than one's thumb, are more than fifty years old, as I determined by counting the rings of growth. The soft, fuzzy catkins on these trees rise above the ground farther than the trees themselves, and tempt the swiftly flying, nervous Arctic bumblebees as few others of the flowers can. Another willow (*Salix herbacea*) is about as tiny a tree as one can imagine. It rarely grows more than an inch high, and has but two little leaves and a tiny catkin each summer. No smaller tree grows anywhere, I am sure. The dwarf birch (*Betula nana*) has been recorded from the neighborhood of our lodge, but I was unable to find it, even after the most careful search where it was supposed to grow.

To the lover of rhododendrons, the little Lapland form which flourishes on the warm, sunny, well watered slopes, is most interesting. Its pretty little rose-purple, plumelike blossoms star the brown basalt rocks about North Star Bay, first cousins to the gorgeous forms that color the ledges of the Appalachians. Two northern species of the cranberry family (*Myrtillus uliginosa* and *Vaccinium Vitis-Idæa*) bear numerous little pink bell-shaped flowers, sweet and delicate as lilies of the valley; but they rarely set fruit, except on the warmest slopes where the summer snows melt as fast as they fall.

Photograph by W. Elmer Ekblaw

Kearsen Steppe, North Star Bay, looking over Wolstenholm Sound,—a typical heath slope of the Arctic, grading to bog at the foot. Such slopes are rarely bright green, for frequent summer frosts continually nip the growing ends of the plants. In late July and early August when the killing frosts begin to come, such slopes may show for a few days stretches of warm autumn coloring, the browns of mosses and the yellows of diminutive willows

The curlewberry (*Empetrum nigrum*) grows in a few favored spots, where its pretty, purple, velvet flowers make it conspicuous, but it bears few berries. The Eskimos like to use it and the fragrant branches of the heather (*Cassiope tetragona*) to make outdoor fires over which to boil their tea or coffee.

The so-called Arctic heather (*Cassiope tetragona*) is one of the prettiest flowers of the northland, and it grows almost everywhere. Its dainty, cream-white bells color some of the rocky slopes. This, and *Dryas integrifolia,* a starry blossom of the same hue, are perhaps the most numerous of the conspicuous Arctic flowers. These two flowers begin blooming early, and continue until August comes with its frosts and freezes.

A group of pretty flowers usually found on rocky ledges that the ptarmigan is wont to frequent, is that composed of the northern arnica (*Arnica alpina*), a smiling, bright, golden-face, not unlike a diminutive Kansas sunflower; the woolly cat's-paw (*Antennaria alpina*), smaller than its cousins of the far southland, but otherwise quite like them; the dainty pink and white shinleaf (*Pyrola rotundifolia*), its thick, glossy leaves and fair blossoms seemingly modeled from wax; the modest and lonely little bluebell (*Campanula uniflora*) rising blue and gentian-like on its fragile stem; and with them a strikingly beautiful, dark purple grass (*Trisetum spicatum*), of which the plumed tufts are noticeable rods away. This group of plants often includes one or another of the other sun-loving plants of the dry slopes, but they are not so definitely confined to the one habitat.

The lousewort, or beefsteak family, numbers at least three representatives. Of these *Pedicularis hirsuta* grows everywhere along the coast. Its first cousin, *Pedicularis lanata,* a much prettier rose-red cluster of flowers, is not so generally distributed, but at Lifeboat Cove, north of Etah, its bright blossoms dot the moors. At Etah grows *Pedicularis capitata,* a plumelike, golden cluster; it has been found nowhere else in Greenland.

Bluebells (*Mertensia maritima*) I found in profusion at but one place, the little Eskimo village at Sonntag Bay, and there the delta of a small mountain torrent was carpeted with them. On the same delta I found the most abundant growth of *Statice maritima,* a beautiful, dark pink globelet of florets.

Of the cinquefoils (*Potentillæ*), of the rose family, I found six species, all profuse-flowering and golden. But Vahl's cinquefoil is the cheeriest of them all, for its inch-wide blossoms with their saffron centers, shine from every dry slope.

The early purple saxifrage (*Saxifraga oppositifolia*) ushers in a succession of ten of the family, of which none is so beautiful as the leader. It is the earliest of Arctic flowers to burst into bloom; often purple pennants of its gorgeous blooms even border the snowdrifts.

Sixteen species of the cress family inhabit the region. Nearly all of them are white-flowered, but one notable exception is the purple rocket (*Hesperis pallasii*), sweet with the odor of plum blossoms, the only fragrant flower in the North. The *Drabæ* comprise ten of the sixteen cress species. It is to this family too, that scurvy grass (*Cochlearia officinalis*) belongs, that far-famed, reputed preventive of the dread disease, scurvy, which has decimated so many Arctic expeditions. It tastes bitter, like cress. Few of the Arctic plants are eaten by the Eskimo, but they occasionally eat this scurvy grass; more often though, they gather *Oxyria digyna,* a round-leaved plant, sour like our sheep sorrel.

Buttercups, waxy golden and bright, are numerous and varied. Most of them are yellow, but one tiny white form (*Batrachium paucistamineum*) grows in the ponds, its starlike little flowers floating on the water during about two weeks of midsummer. The favorite flower of many explorers is the dainty pink *Silene acaulis* that grows in dense clumps on gravelly slopes, but I could not help feeling that its hard stems were too stiff. The Alpine chick-

Photograph by W. Elmer Ekblaw

It was surprising to find that edible mushrooms grow abundantly at Etah. They attain considerable size, some nearly as large as a dinner plate, and were delicious when cooked.

The climate of the coast of northwest Greenland is far milder than would be expected for the latitude, because strong tides and currents keep open water in Smith Sound not far from the land usually all the year through. This open water produces a moister air and thus accounts in large measure for the relatively luxuriant vegetation of the Smith Sound region

Photograph by W. Elmer Ekblaw

Even before the snow melted away, the plants on southern slopes at North Star Bay were budded for blossoming. On land that is level the rays from the low Arctic sun strike only obliquely, but they strike the slopes of course more nearly perpendicularly. Therefore, if the slope be southern and thus protected from cutting winds, the temperature of the soil may rise rapidly. Under the influence of this warmth and of the moisture of the fogs so frequent in summer, the low shallow-rooted plants of the Arctic flourish

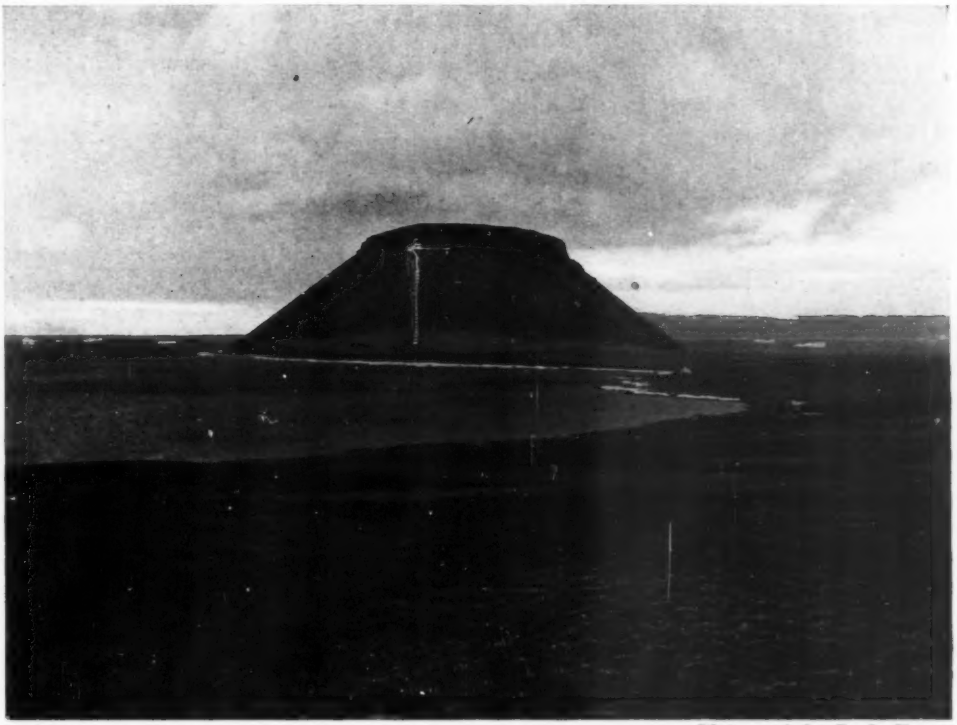
weed grows cheerfully everywhere, seemingly undaunted by the most unfavorable conditions. One of its near cousins (*Melandrium triflorum*), an Arctic catchfly, is found nowhere but in Greenland.

The dandelion, so despised in the southland, merits more respect and consideration in the northland. Besides the bright, golden forms, closely resembling ours, a white-flowered form (*Taraxacum arctogenum*) with pink border grows in profusion about Etah, and grows nowhere else in the world, so far as known. It would attract attention anywhere as a pretty flower.

It is to the sunny-faced Arctic poppy, however, that the explorer is always ready to give the highest praise. To the farthest northland that man has yet attained, this fragile, but hardy little blossom, has preceded him. On the

Photograph by W. Elmer Ekblaw

The tundra in general view appears barren and monotonous, but reveals variety and beauty of detail when studied close at hand. The most characteristic plant of the heath-forming association that grows on warm sunny slopes is the andromeda (*Cassiope tetragona*) with white bell-shaped flowers. In places it forms a continuous carpet (as shown in the background in the photograph). Rarely one finds the curlew-berry (*Empetrum nigrum*) growing with it on the protected slopes of deep fiords



Photograph by E. O. Hovey

At North Star Bay, in the summer of 1914, the botanist of the Crocker Land Expedition found eighty species of plants within a radius of one half mile. Every day he made long tramps over the rough interior country, or sledge journeys to points along the sound. This year of 1914 was one of misfortune—except as to work. In March he had led one of the advance parties across Ellesmere Land ready for the Crocker Land search over the sea ice, but had been obliged to return to Etah because of badly frozen feet. Afterward, in April, he proceeded to North Star Bay to engage in a botanical survey. Misfortune followed him. At one time, he experienced for several days the agonizing pain of "snow blindness." At another, he narrowly escaped drowning when the ice gave way under him, his sledge and dogs—rescue being effected largely through the continued struggle of his big white king dog. And for several weeks here at North Star Bay he faced starvation, while only 130 miles away at Etah, but unobtainable, was food in plenty. Throughout the summer the party was on extremely short rations, always hungry, and always watching the point on the horizon where a relief ship might appear.

The photograph shows Dundas Mountain, 700 feet above sea level, and at the right about one mile from its base, the buildings of Thule Station, a base for Danish exploration (See AMERICAN MUSEUM JOURNAL for May, 1918, page 391)

most lonely and desolate coasts it greets him all summer long whenever he travels there. Along the icebound seashores, upon the bleakest plateaus, in every lonely valley, wherever a crevice in the rocks or a pocket in the cliffs gives it foothold, it is sure to establish itself. Great fields of it flamed about Etah, and about our headquarters house it grew abundantly.

No great, green meadows or pastures carpet any part of the far northland, but on the sunny slopes where some of the numerous Arctic birds have formed a rich guano soil, the turf becomes thick and soft. The frequent frosts that come through the summer, sear the delicate tips of the grasses so that they never appear verdant; a real green slope, therefore, is a rarity in the Far North. The most lush-growing grass is the misnamed Arctic timothy (*Alopecurus alpinus*) upon which the Eskimos depend for padding to place between their stockings and boot-soles and under the skins of their bed platforms, and for dishcloths or towels with which to wipe dry their few pots and pans. Many blue grasses grow in Greenland, but about the Eskimo villages, Kentucky blue grass (*Poa pratensis*), tall and thick, is the most common form. In a few of the shallower ponds along the coast grows the beautiful little *Pleuropogon sabinii,* unique in its genus.

Pretty, plumy cotton grasses (*Erio-*

phorum polystachium and *E. Scheuchzeri*) wave their white tassels along the banks of the streams and pools and in the wet swales; graceful little rushes and reeds (*Juncus* and *Luzula*) grow with the numerous sedges (*Carex*) to form mats of turf where no grass grows; harsh scouring rushes (*Equisetum arvense* and *E. variegatum*) form mats on some of the flatter stream beds, and a yellow-green club moss (*Lycopodium selago*) dots the upland swales; all of these help to create variety in the Arctic vegetation.

Photograph by W. Elmer Ekblaw

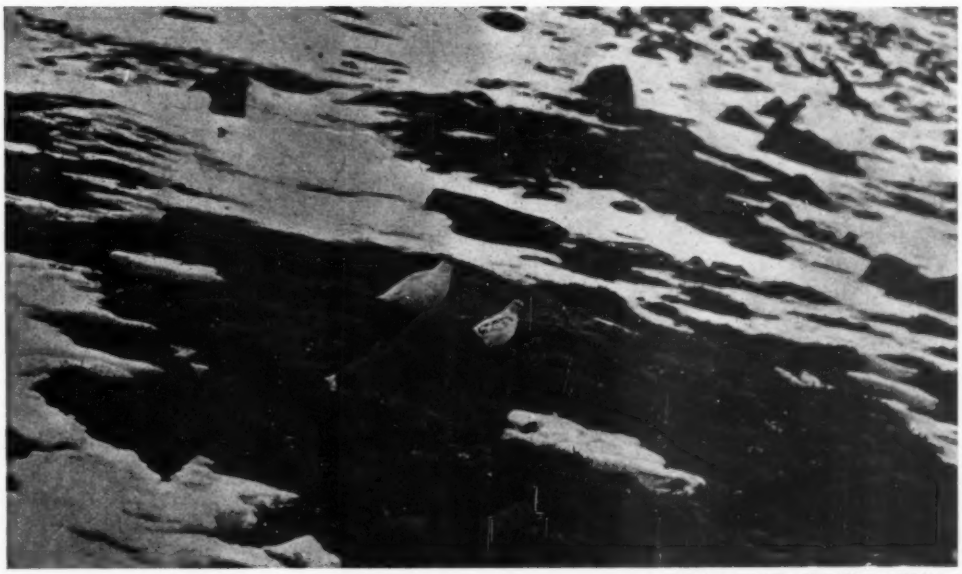
Mats of mountain avens on crescent-shaped areas of earth resulting from the disintegration of the rock. This disintegration has been accomplished through the action of overlying snow, drifted by fierce blasts of wind down the fiords. The hardy little *Dryas* (its flowers are shown on the opposite page) is probably the most common plant in Greenland. It is absent from few places where there is any vegetation at all, maintaining a foothold even on plains of bare rock débris. It flowers by the middle of June and continues to blossom throughout the short summer

Rather unexpected, but none the less welcome, four diminutive ferns that grow on the rock ledges carry one back in memory to the southland. *Cystopteris fragilis,* the commonest fern of the North, grows abundant and luxuriant in moist crevices on the steep cliffs. *Aspidium fragrans,* rigid but beautiful bronze-green, is a sweet smelling fern found on sunny shelves. Two little woodsias, *Woodsia glabella,* a Lilliputian form scarce an inch high, and *Woodsia silvensis,* not much larger, complete the list of ferns.

To end the account of the vegetation of the northland without mentioning the large, edible mushrooms at Etah would be to leave the list incomplete. They are of a species probably not hitherto known. Some of them grow as large as dinner plates. They could stand for days, unspoiled and untouched by insects, and still be almost as good to eat as when fresh. Dr. Hunt and I gathered many, cooked them, and ate them. We considered them excellent.

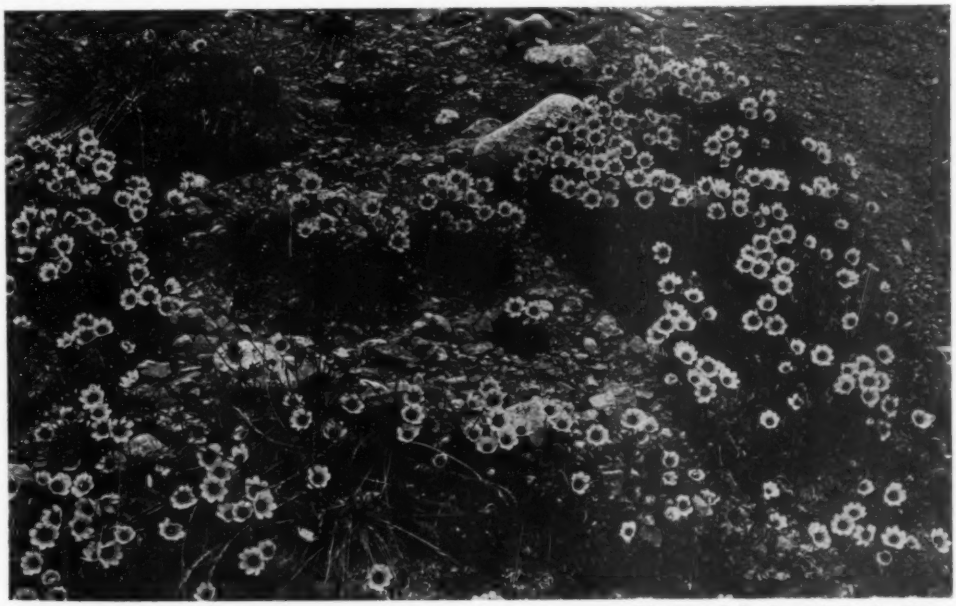
The plants and flowers of northwest Greenland have hardly two months in which to grow. As soon as the snow melts, the first flowers begin to appear, usually only a few days before June first. At that time the midnight sun is a month and a half high and gives almost as much heat at midnight as at noonday. Even so, frequent summer snows and cloudy weather often retard the development of the plants so that they cannot blossom before the killing frosts begin to come in early August while yet the midnight sun graces the northern sky. In mid-July even, the little willow leaves begin to turn yellow, and a week or two later the autumnal golds, and tans, and browns indicate that the season of growth is ended.

The flora of Greenland is a mixture of European and American forms. Many interesting problems present themselves in the occurrence and distribution of many of these forms, and much work has been done toward their



Photograph by W. Elmer Ekblaw

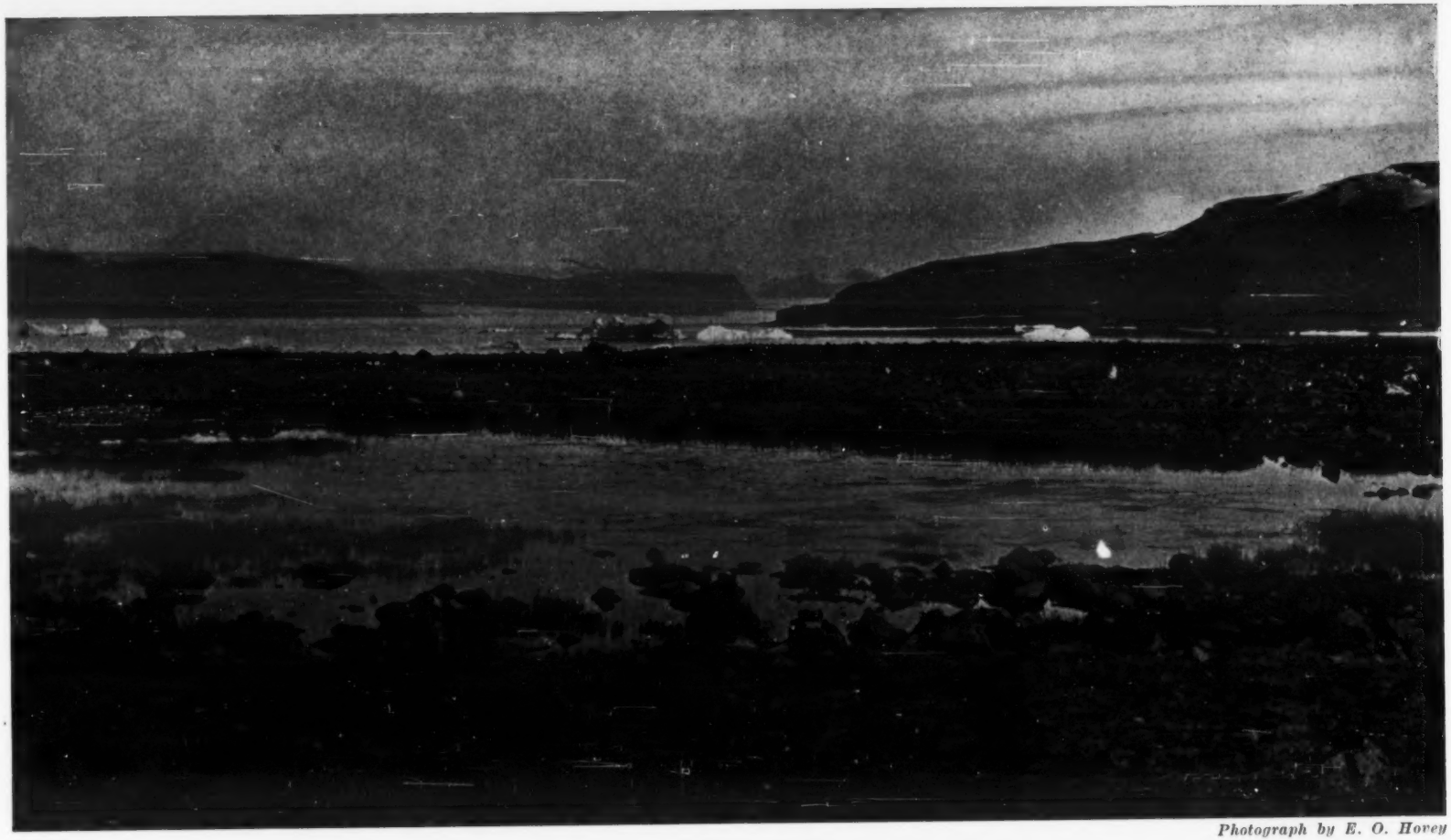
At the time when the ptarmigan were courting on warm, dry, Arctic slopes where the snow had melted early, the botanist could always be certain of finding a particular association of small, low, sun-loving plants. Among these were the yellow arnica, white woolly heads of "everlasting" or "cat's-paw," waxen pyrolas, and fragile, solitary bluebells **(see page 278)**



Photograph by Donald B. MacMillan

The white starlike flowers of the little mountain avens (*Dryas integrifolia*) are found on the inland plateaus and moraines which otherwise would be quite bleak and desolate. This small representative of the rose family seems to be able to maintain itself everywhere and its multitudes of flowers often give color to the whole mountain-side

solution. As yet, however, the evidence for definite conclusions is not available, but it is to be hoped that the collections and data obtained by the Crocker Land Expedition will make a considerable contribution to the knowledge needed.



Photograph by E. O. Hovey

VIGOROUS PLANT GROWTH IN A SUMMER ARCTIC POND

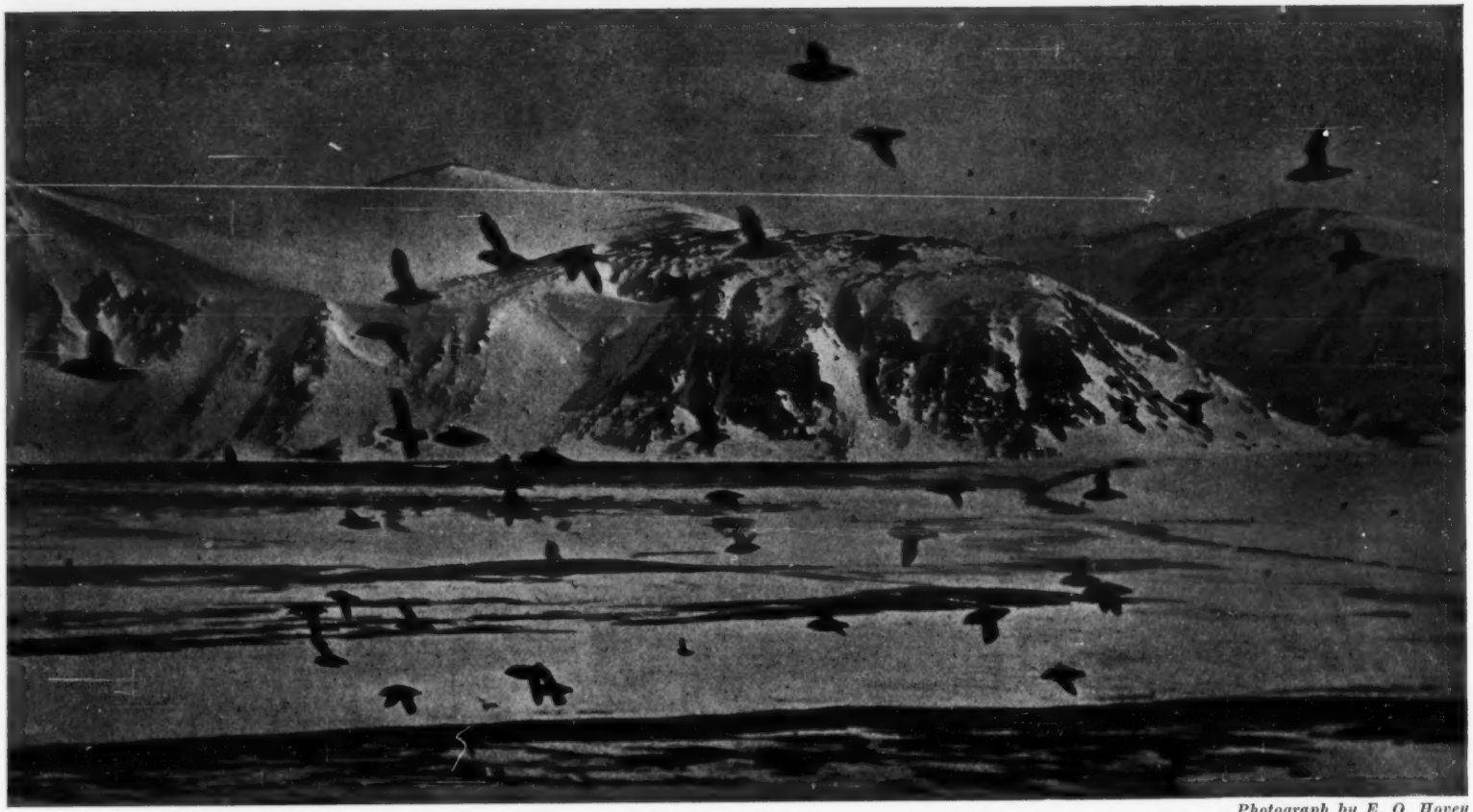
Such a pond (like the one shown on page 275) has probably come as a residuum of melting snows. Snowdrifts on Arctic slopes give rise to sporadic streams (see upper cut, page 288), but in flat country without drainage, to lakelets or ponds, frozen at the bottom in the deeper portions and freezing early from the bottom upwards. In the grasses and sedges about such ponds the red-throated loon nests, feeding on small fish which come into activity in the pond each season. The beautiful little Polar grass (*Pleuropogon sabinei* f. *aquatica*) which grows in the shallow parts of the pond among the rocks and covers the water with its narrow green leaves spread out in floating mats, and its tiny heads of "seeds" thrown above the water like minute rosy flags, is interesting in having also a small dry land form (f. *terrestris*) growing in crevices of the soil.

The view is at North Star Bay looking up Wolstenholm Sound, with Moltke Glacier entering from the left and Rasmussen Glacier from the right

Photograph by Donald B. MacMillan

GREEN GRASSES COVER RUINS OF DESERTED IGLOOS

Yellow brown is the color of the tundra seen in general expanse from a distance. Spots of vivid green are likely to indicate an Eskimo camp, possibly some ancient camp, with ruined igloos, because the Smith Sound Eskimos move their camps from place to place along the coast, driven by lack of food and led by abundance—of narwhal, of walrus, or of seal. Various species of blue grasses (*Poa pratensis*) grow on these relatively fertile spots, among them the Kentucky blue grass, also the so-called Arctic timothy (*Alopecurus alpinus*). It is the timothy, dried, that the Eskimo depends on for many domestic purposes—especially he stuffs his boots and mittens with it before putting in his feet or hands, thus adding many layers of nonconducting air to the protection, and he piles dry timothy on the bed platform before spreading out the caribou and polar bear skins



Photograph by E. O. Hovey

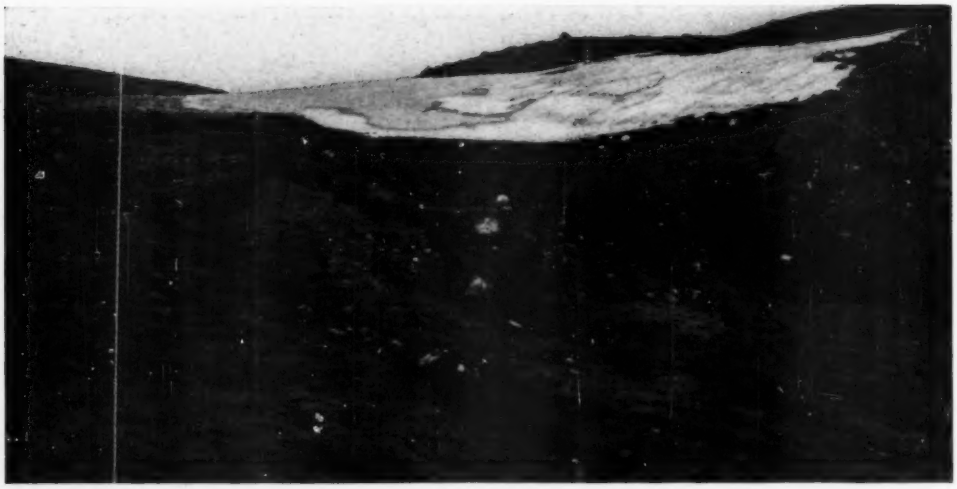
SUMMER STORMS BLANKET THE EARTH

North-facing cliffs have little plant life, but those facing the south are likely to be the homes of countless little auks and to have the talus slopes and the ledges covered with the green of grasses and the yellow and white of flowers. The strong gales and the dryness of the atmosphere greatly retard plant growth at the North. The low temperatures of both air and soil slow up growth. Also the continuous sunlight day and night for the greater part of the growing season (June, July, August), while allowing plants to make speed in seed production, inhibits growth in length of stem and spread of leaf (plants manufacture starch in daylight, the powers of growth are facilitated in darkness). We must expect a stunted and meager flora on circumpolar lands. The limit of trees reaches north of the Polar Circle in Siberia but is considerably south of it in Labrador. Beyond, wherever the land is ice free, is the "tundra," a vast open expanse covered sparsely and irregularly with grasses and lichens, intermixed with stunted grasses, sedges, and other flowering plants. The photograph shows valley and cliffs (700–900 feet high) at Parker Snow Bay, between North Star Bay and the great glaciers of Melville Bay

Photograph by Donald B. MacMillan

FRONTIERSMAN OF THE PLANT WORLD

It takes more than a summer snowstorm to dull for long the gold of Arctic poppies. The Crocker Land Expedition recorded purple saxifrage (ushering in a series of ten members of the saxifrage family) as the first flower to bloom at Etah (June 9), but that soon afterward the poppies began to open—among many other yellow flowers, such as arnica, buttercups, and dandelions. That different species can endure different degrees of cold is probably inherent in the protoplasm and a matter of heredity. Poppies are hardy and prove it by flourishing to the very edge of the Polar Sea only 370 miles from the North Pole. Many flowers at the North appear unusually large because of contrast with the dwarfed stems and leaves, and their color is always vivid. Arctic poppies are usually transparent mandarin yellow in color but in some localities a white form grows abundantly



Photographs by W. Elmer Ekblaw

A BARE AND BLEAK LAND, EVEN WHEN ICE FREE

Along a narrow stream at North Star Bay (picture above), the heath and moor are finely carpeted with the pretty Polar rhododendron, with creeping cranberry, and with Arctic willow

At this walrus hunting camp on Sonntag Bay (middle photograph) the botanist collected three species of plants which he found nowhere else along the whole North Greenland Coast. Many plants of the North are thus restricted in distribution

On Arctic slopes soil-flow streams move slowly, like veritable "glaciers" of rock and soil (photograph at bottom of page). They present conspicuous scalloped fronts, covered in this case with cranberry, and the very edge of the advancing soil is outlined in northern heather

Photograph by E. O. Hovey

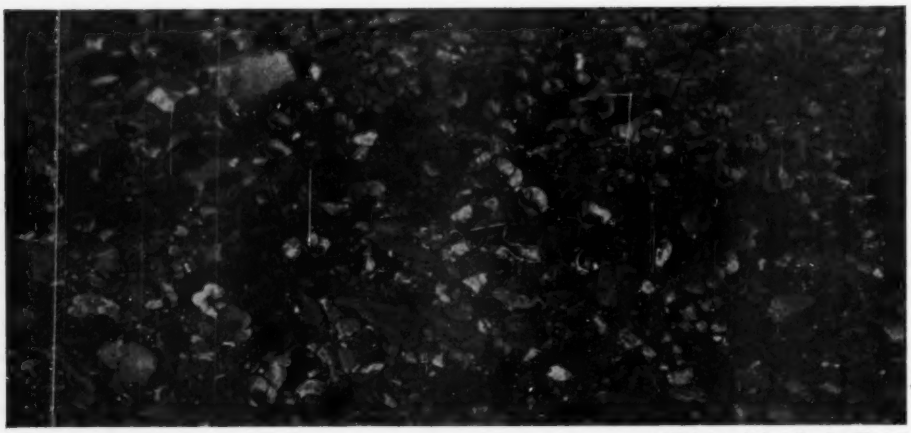
In many places at North Star Bay, in July, bright orange lichens, brilliant as flowers, adorn the rocks and give the dominant tone to the landscape. Lichens and mosses largely make up the flora of the coldest Arctic tundra, tending to be distributed in different local areas. The crevice in the rocks indicated in the photograph by the pocketknife opens below into the nest of a snow bunting, which each summer comes from southern regions to make its home in this far northern spot

Photograph by W. Elmer Ekblaw

On the dry inland slopes where the old squaw (*Harelda hyemalis*) hides her nest, often miles from water, grow many lichens, sedges and grasses, and dry heath plants

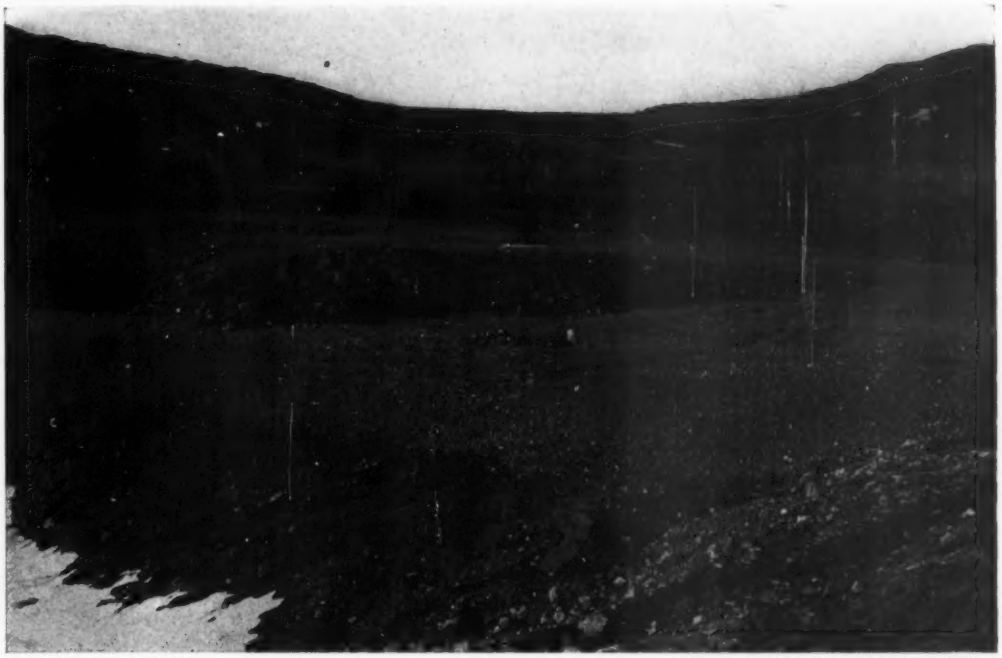
Photograph by Donald B. MacMillan

Like the crimson poppies of Flanders Fields, these yellow poppies grew where have been wrought heroic deeds which live in history. The golden Arctic poppy (*Papaver radicatum*) for a few weeks in summer greets the botanist with good cheer wherever he may wander. He has known Greenland during the long Arctic night as a stern land of bleakness and desolation. But some day in summer when he enters one of the forbidding fiords, shutting out a view of the ice cap above and the icebergs on the sound outside, he concludes that Greenland after all is not a grim, barren spot. For every little crevice in the rocks is foothold for some fern or glowing flower, every little pocket of soil refuge for a bit of verdant turf, and every little slope or ledge shelter for willow, heather, or smiling poppy



Photograph by E. O. Hovey

There were about seventy-five poppies in this gleaming mat of yellow on the bare shingle flats (North Star Bay). In favorable localities they are so abundant that it is no exaggeration to speak of "fields of poppies." These northern pioneers in no way lack in beauty of hue or of texture when compared with the golden poppies of California. Many Arctic species bloom profusely. *Draba* plants may be rounded out into spheres wholly yellow or white with the multitudes of flowers



Photograph by Donald B. MacMillan

How bleak and drear and lonely is the general landscape of the coast lands! This is at the head of Port Foulke, two miles southwest of Etah, where the ground is made up of the barren rock of an ancient seabeach. The Hayes Expedition of 1860-61 had its winter quarters here. The grave (see the center of the photograph) is that of August Sonntag, an explorer-scientist who lost his life in the ice of Smith Sound in December, 1860, while a member of this expedition. He had also served as astronomer with Kane, the first American explorer, on his expedition of 1853–55. The chiseled slab at the head of the grave, bearing the inscription, still stands against the weather

Photograph by Donald B. MacMillan

Helping to gather poppies at Etah in June.—The Eskimos delight in the brilliant flowers of their picturesque country, but are on the whole, of course, far less observant of plant life than of birds and animals

Our Centrifugal Society

Is our current expansive philosophy of life, based upon liberty, equality, and self-expression, a safe and sufficient guide for the development of a high social order? Should it not be balanced by the unifying and integrating forces which come from self-restraint and control, moderation, and the limitation of desires? These may lead to a far higher self-realization

By G. T. W. PATRICK

Professor of Philosophy, State University of Iowa

OUR present reconstruction period differs fundamentally from other such periods following other great wars. It is not quite safe, therefore, to rest in any easy assurance that in a few years all will be well, since a period of painful reconstruction must follow every great war. It is becoming evident now to all of us that we are confronted, not merely with a political and economic reconstruction, but with a radical social reconstruction.

Long before the war it had come to be believed that society was on the sick list, needing drastic treatment, if not a major operation. We had become painfully conscious of certain social "evils," and our attention was fixed more and more upon certain loudly advertised "cures" for these evils. Among these evils were the unequal distribution of wealth and opportunity, the constant clashes between labor and capital, the unjust exclusion of women from political and economic privileges, the alcohol evil, social diseases, poverty, crime, and the falling birth rate. Among the proposed "cures" were the further extension of democracy, socialism, syndicalism, votes for women, national prohibition, and coöperation.

Then came the war, and at once our attention was focused upon this as the worst evil of all. That such an awful calamity could suddenly befall the world increased still further our distrust in our whole social system, and we began at once to search for some cure for this further evil, and hoped to find it in a League of Nations, international agreements, and the self-determination of peoples.

The Spark of Divinity in the Human Mind

It is characteristic of our age to be peculiarly sensitive to its evils. This sickening feeling that the world is in a very bad way and needs redemption is illustrated in the book written by Alfred Russel Wallace shortly before his death, in which he bewailed the degeneracy of the times, dwelling upon the prevalence of poverty and crime, and frightful social diseases, and social injustice, in a note almost of despair.

Certainly it is a hopeful sign that we have become so sensitive to injustice, so conscious of social evils, so intolerant of wrong doing, so repelled by the horrors of war, that our own era, which is really clean and wholesome and peaceful and righteous as compared with past periods in human history, seems to us so imperfect. There is thus at any rate this element of hope in the situation that there must be some spark of divinity in the human mind, since we compare the present, not with the real past, but always with the ideal future.

Conscious Control of Man's Future—Will it be Intelligent and Beneficial?

The special characteristic of our time is therefore not the presence of evils, of which to be sure there are quite enough, but the peculiar consciousness of them and the resolute will to cure them,—a will so persistent and so determined that it is certain that the twentieth century will see profound changes in our social order. But it does not follow necessarily that these changes will be

beneficial. They will be experimental. This is the first time in history that man has consciously and with determined purpose entered upon the task of directing his own fortunes. Hitherto he has been a puppet in the hands of cosmic forces: evolution, climate, the struggle for existence, the industrial revolution wrought by mechanical inventions and the discovery of coal, iron and petroleum, and finally, the retroactive influences of the American and Pacific frontiers. Now the period of conscious control has come.

But is this conscious control to be intelligent control, or is it to be the kind which the newly rich suddenly acquire over their material surroundings? So far as we can see at present, the era of intelligent control lies far in the future, and the control which is to mark the twentieth century will spring from an impulsive idealism characterized by a keen sensitiveness to our present social evils rather than by a comprehensive grasp of the whole social situation. We are to enter upon the deliberate attempt at social reconstruction but with a kind of adolescent impetuousness and a fatuous, almost fanatical faith in the magic of certain social symbols to cure social evils. This is, no doubt, a necessary stage in the progress of social control, but it is not without its dangers. We have gained the power to remodel our social order. Have we gained the necessary poise, the scientific, historical, and psychological knowledge that will make our meddling safe?

There is, in all the discussion of evils and the cures for them, a singular disregard of the psychological and historical factors of the situation, and a strange forgetfulness of the fact that however important social and political readjustments may be, the world cannot be made over as long as the human material, the minds and bodies of men, remains the same. The relatively greater importance of education, of physical and mental health, of racial integrity, of universal intelligence and self-control, is overlooked.

The Present Philosophical Basis of Social Reconstruction

But my purpose in this article is to call attention to the philosophical basis of the reconstruction movements of the day. Underlying all these movements is the philosophy of the full, free and abundant life; of self-expression; of self-determination; of self-realization; of freedom from every kind of autocracy or class rule or oppression or repression; of equality of opportunity; of freedom for self-development and culture; of complete liberty to realize one's own inner needs and one's own personality; of escape from all old and cramping conventions and institutions; of naturalness, initiative, power, will, and efficiency.

These are our ideals and to most of us they are so obvious that they seem to need no discussion. They have found expression in our current drama and fiction, in our moving pictures, in our books and magazines, and in all our plans for social reform. We have come to take them quite for granted.

Is Self-expression an Obsession?

Perhaps it may be worth while to examine these ideas with a little care. As ideals they are obviously good. This may pass unchallenged. But it is not self-evident that they are the highest ideals, nor is it self-evident that they are alone sufficient as a foundation for social welfare. It seems rather that the present age is merely obsessed with these ideas, just as other epochs of history like that of the ancient Hebrews, or that of Greece and Rome, or that of the Middle Ages, were obsessed with a wholly different set of ideas.

For instance, in the Middle Ages, poverty, chastity, and obedience were the monastic virtues, and every ambitious boy aspired to be a monk. We look in vain now for many ardent devo-

tees of poverty, chastity, or obedience. Our attitude toward these medieval ideas is one of humorous superiority, not perhaps fully justified by the relative differences in the two civilizations as measured by such standards as social stability or the development of the fine arts, such as architecture, painting, and poetry.

Still another set of ideas ruled in the best period of Grecian civilization, likewise wholly different from ours. These were temperance in the sense of balance and moderation, measure, limitation, order, form, harmony, symmetry, and beauty. Francis Galton perhaps spoke with some exaggeration when he said that the average intelligence of the Athenian race was at least two grades above our own. But while we may smile at the ideals of the monks, we must take very seriously those of the Greeks as long as we are still using as models so many of their masterpieces of political philosophy, poetry, sculpture, architecture, eloquence, and literature. It is all a matter of historical perspective. Some future period may smile at our child-like devotion to liberty, equality and fraternity, or self-expression, or the full, free and abundant life, to the neglect of many other equally important ideas.

Is the Philosophy of Expansion a Safe Philosophy of Life?

In all our discussion now about social reconstruction and a new social order, is it not a little peculiar that the ideas which we are trying so hard to realize in this new social order,—liberty, equality, efficiency, opportunity, self-expression, and self-determination, —are just the ones that already mark this period when compared with other past periods and past civilizations? We may be deficient in these virtues, but we have them in profuse abundance as compared with other times, and we have them in excess as compared with other virtues, such as love of beauty and of symmetry, proportion, moderation, measure, and limitation of desires. Is it safe to enter so passionately upon the remodeling of our social institutions with our eyes fixed so exclusively upon any one circle of ideas?

Self-expression is perhaps the best single term defining our present day philosophy of life—or, possibly, self-realization, or initiative, or energy. The keynote of modern painting, music, and poetry is expression, and that of modern sculpture is energy. In our educational systems our aim is to develop all the latent energies and possibilities of the child. He must express himself, bring out the full richness of his personality, give full scope to his individuality, develop to the utmost his genius and his talent. When manhood and womanhood are attained, old social conventions must not stand in the way of this inner need of self-realization and self-expression. Our laws must be remade and our social institutions reconstructed so that each individual may enjoy his full rights and come into possession of his full share of the world's goods. It would be a shame if others had superfluous wealth while any lacked the means of self-development and self-culture.

This is the expansive philosophy of the age, the centrifugal motive in society, moving from within outward. But the ancient Greeks thought it better to draw from without inward, to observe limits and measure, to strive for inward poise and harmony. This is the centripetal motive in society, the unifying and integrating tendency.

Germany's Experiment in Self-expression

It would be interesting to attempt an evaluation of these two methods. When Plato was unable to find the definition of justice in the case of the individual, he solved the difficulty by examining the idea as magnified in the state. So just recently we have had an instructive

example of the trial of this philosophy of self-expression in the case of a great state. Germany five years ago had a deep longing for self-expression. She felt that she must expand, bring out the full richness of her personality, develop to the utmost her genius and her culture, give full scope to her peculiar individuality. Old international conventions and treaties between states must not stand in the way of her inner need of self-realization and self-expression. Old laws must be reinterpreted so that she might have her full share of the world's goods. It would be a shame if other nations had superfluous colonies while she lacked the sphere of self-development.

But Germany made the unhappy discovery that there were other peoples who also desired self-expression, who also had a personality to conserve, a "mission" to fulfill. Five years ago self-realization was within Germany's grasp. She had valuable traditions of education and science, of art and philosophy. She had great wealth, vast industries, and a fruitful commerce, and she had the friendship and the respect of the world. Self-realization in the larger sense she could have had through the practice of the Greek virtues and the minding of her own business.

Limitations and Dangers of the Centrifugal Motive

It is important to understand the meaning and value of this new idea of the full and exuberant life. Its value we all recognize. Its limitations perhaps we do not realize. To many in the present day it seems like the very word of promise. It emancipates us—so we think—from all the narrow and cramping and dwarfing and galling restrictions of the past and sets us free to enjoy, to live, to breathe deeply, to develop as we please. It emancipated our slaves. It is emancipating our women. It will emancipate our laborers. If this new gospel of energy, of affirmation, of spontaneity, of self-expression, does not work well in the case of nations, there must be—so we imagine—some error in the analogy, for as regards the individual it is the very evangel of our modern era. If there is any one idea prevalent now it is that there is something intrinsically sound and helpful in this renouncing of old authorities and traditions in favor of our primal instincts. Instinct, impulse, nature, the spiritual life—to dampen these, to dampen this inner need of self-expression, this demand for joy, is the only sin.

This modern gospel of self-expression takes innumerable forms. With Nietzsche it is the will to power, gained through tragic suffering and pain. In Christianity it is the triumphant realization of an essentially divine and spiritual individual life revealing itself in the typical modern expansive virtues—faith, hope, and charity. In Bergson it appears as the exaltation of instinct and primal creative impulse. In Goethe it is pictured as salvation through successive forms of objective experience. In Browning it is seen in the wild joy of living, in buoyant faith, optimism, and love. Even in the modern mystic it is no longer passive resting in God's encompassing arms, but, as in *Jean Christophe,* an intoxication with the madness and fury of living. In the modern psychological novel it is the coming into some mysterious larger and fuller life through the conflict of motives and through rich subjective experience. In the modern drama, sometimes nothing but the experience of sin itself will bring it to complete fruition.

In all these forms of self-expression, the common motive is the centrifugal motive, marked by a craving for excitement, impatience with restraint, a longing for freedom and expansion, for the enhancement of life, for the intensification of consciousness.

With this note dominant in our modern life and literature, it is foolish to

speak of social or racial or national decadence. Clearly, the world is not suffering from age and decadence. It has the virile enthusiasm of youth, but with it also the defects of youth, an almost childish impetuosity and imprudence, a tendency toward no remoter end than the mere intensification of the momentary mood of joy and strength.

Need of the "Inner Check"

What is lacking in all these forms of self-expression is the "inner check," the motive of restraint and reserve, the discipline of the wise man who looks beyond the present.[1] In Platonic phrase, it is "justice," the justice which the young man owes to his coming years, the justice which each generation owes to the next, the justice which each individual owes to society. Every young man is free to live the full and abundant life up to the point of not infringing upon the strength and integrity of his coming manhood. Every generation is free to live the full and abundant life up to the point of not infringing upon the health and happiness of the next generation. Every individual is free to live the full and abundant life up to the point of not infringing upon the full and abundant life of all the others in the group.

But the limitations come quickly and fast. Therefore, restraint is necessary; and will be increasingly necessary. There is no error here in the analogy between the nation and the individual. Germany complained before the war that she was fettered by a surrounding iron ring. To be fettered by an iron ring is painful. She longed for expansion. But the world has had a wholesome lesson from the war. Hereafter expansive nations will understand that they must do their expanding within their own borders. The days of territorial expansion are gone by. And it is to be feared that there will soon be a limit to economic and commercial expansion. In fact perhaps the virtues of the future will be not expansion, not self-expression, but self-control and limitation. And can we be sure that these latter may not be the surer road to peace and happiness? Possibly there is a higher kind of self-realization than that found through self-expression. Self-realization may indeed be the highest goal of human endeavor, but the self to be realized may be the larger self of our collective being, including succeeding generations.

This is nothing, of course, save the age-old antagonism between liberty and justice. It is merely the habit of our modern thought that we have become so enraptured with the first of these that we have overlooked the vital importance of the second. Of course, we hear a great deal now about justice, but it is social justice that we have in mind, that glorious social state in which each class shall enjoy all the fullness and richness of life that any other class enjoys. It is not at all that kind of justice which Plato taught us, consisting not in *having,* but in *doing* one's full share. Plato understood, as all the older teachers did, that the centripetal forces in society must balance the centrifugal forces, if we expect stability in our social life. With Plato justice was the centripetal integrating principle. It was realized when every class, and every individual, performed its function in the state—in plain terms, did its duty. It was a socialistic state, but evidently the fundamental purpose was different from that of our modern socialistic state, in which the attention is focused more upon our rights than upon our duties.

Socialism as it exists in theory today involves, unfortunately, no radical change in our current spiritual ideals. It accepts without much question the philosophy of the full and abundant life, and proposes usually a series of administrative and industrial changes,

[1] Compare Paul Elmer More, *Platonism,* Chapter V.

which it is hoped will do away with certain evils of the time, such as inequality of wealth and opportunity, and the selfish exploitation of the laboring classes. The emphasis in all these modern movements is put upon getting one's full share of the good things of the world—food, clothing, wealth, leisure, and opportunity—to the end always of comfort, happiness, self-expression, self-realization, self-development.

The ancient socialistic state, on the other hand, was one in which the attention was focused, not on the individual benefits to be enjoyed, but on the loyal part in the whole undertaking which each was to play to the end of having a healthy and permanent society. And they well understood that in the long run the individual found his greatest happiness, his highest good, when he fixed his attention on the permanence, stability and health of the social group. A social group in which the human units focus their attention upon getting each his full share will not bring to its members as full and abundant a life as a group in which the attention is fixed upon doing each his full part.

Our modern conception of the perfect state is one in which certain "evils," such as poverty, inequality, intemperance, clashes between classes, and wars between states, are to be absent. Poverty is to be abolished, not by self-denial and a limitation of desires, but by the increase of wealth through efficiency, scientific management and new mechanical inventions, and by new *laws* regulating the production and distribution of wealth. War between nations is to be abolished, not by curbing our instincts of pugnacity, not by education in restraining our expansive desires, but by some new political contrivance such as a League of Nations. Intemperance is to be done away with, not by making men strong to resist temptation, but by an act of legislation removing the occasion of temptation. Disease is to be abolished, not by assisting nature in providing powers of resistance to disease, but by devices to protect men from the causes of disease. Inequality between the sexes is to be removed, not by fostering respect for womanhood and motherhood, but by votes for women and political privileges.

I would not be understood as belittling the absolute value of democracy, and socialism, and feminism, and prohibition, and a League of Nations; but we over-emphasize their total relative value for social welfare, even if we consider only the welfare of the present generation. No society will survive without the integrating motive—the presence of justice in the Platonic sense. The world is stirred today by powerful centrifugal forces. Like a wheel, it will fly into pieces unless it is held together by equally powerful centripetal forces. These integrating forces are measure, self-control, obedience, respect for law and authority, restraint, limitation of desires, the feeling of obligation. As one writer has said, we have a superabundance of vital energy; what we need is vital control.

The finishing touch has finally been given to our philosophy of expansion by Freud, who has shown us that the repression of our instincts and desires is dangerous. Why, yes,—dangerous now and then for the individual, but singularly wholesome for society! It is really very naïve, this discussion about the danger of inhibiting our natural impulses. Freud might have read in a certain ancient writing of a certain wise teacher who said, "If any man will come after me, let him deny himself and take up his cross and follow me."

The great cry now is for equality of opportunity. But opportunity for what? If pressed for an answer, we say opportunity for self-development. Really it is opportunity for advancement, for wealth, for power. We seem to be blind to the existence of other

higher and more enduring values. The society which we picture for the future is always built on the Chautauqua plan. What we think we want is physical comfort, leisure for self-improvement, peace and quiet in which we may work, freedom from interference and escape from fear; but actually life is something very different. Our socialistic society of the future pictures man as surrounded by comforts, working six hours a day and "enjoying" ten hours of leisure which he is supposed to spend in self-development; and when all this happens it is assumed that he will be happy and contented and peaceful.

A very little knowledge of human psychology ought to dispel this dream. Life is anything but a Chautauqua gathering. Life is a struggle and must have the zest of struggle. There are values higher than comfort and leisure and material goods, and other virtues which we need to emphasize more than faith, hope, and charity. In an age of despair and depression for the masses of people such as the beginning of the Christian era, the expansive, outward and upward-looking Christian virtues were like a great light from Heaven. In a vital, expansive, centrifugal period like the present it may be necessary for us to return to the integrating and harmonizing virtues of the Greeks,—wisdom, temperance, moderation, and restraint; and it may be necessary for us to revise our list of highest values and in place of wealth, leisure, liberty, equality, and opportunity, write for a while conservation, limitation, integration. The great things of life, wisdom and art and literature and heroes, have sprung from periods of storm and stress. It is such periods that have given birth to *opportunity;* but it was not opportunity for self-development, but opportunity for self-control, yes, even for heroism and for love.

To be sure, we hear much about love, but it has come to take the forms of sympathy and charity. Of both of these we have a great and abundant measure. What we are trying to do in all these modern forms of social reconstruction is to hit upon some social or political device by which we may live the full and exuberant life and allow our neighbor to do the same. There never was so much world-wide sympathy for the neighbor who does not live the full and exuberant life as there is now. We love and sympathize with every oppressed class and every down-trodden man. We are taught to love our neighbor, and we have learned to love him with such intensity that we allow no one to exploit him but ourselves. As Professor Babbitt says, "Our twentieth century civilization is a singular mixture of altruism and high explosives." We love our neighbor and we wish him every joy. In his need we shower him with charitable gifts. If others abuse him, we are ready to fight for him; but our conception of love does not quite extend to the notion of limiting our own desires for our neighbor's good. It does not quite suffice to check the megalomania of our capitalistic classes, nor persuade them voluntarily to bear their just proportion of public taxes, nor teach them willingly to share their profits with their workers. It does not quite suffice to lead our laboring classes, when once they find power in their hands, to use this power in accordance with reason and moderation.

It is owing to accidental reasons that the necessity for restraint and limitation has not been laid upon us in recent times. The discovery of America, the industrial revolution, the Pacific frontier—all these have opened to us a new world which has allowed the human spirit an indefinite expansion foreign to its long history. There has been for a short period in human history little need of the "inner check," and it has been almost forgotten.

To be sure, this wild display of centrifugal forces has brought no essentially valuable human product, no great

literature or art, no Grecian temples, no Gothic cathedrals, no Shakespearian drama; nor has it brought peace among men, nor physical stamina of race, nor freedom from vice and misery and crime, nor justice, nor reverence. In the midst of plenty, it has not abolished greed, nor graft, nor strife. But these defects have been little noticed, and meanwhile there has been stirred within us only a desire for still more rapid expansion.

Only lately have the first signs appeared to teach us that limitation belongs to the nature of things and cannot be escaped. In the crushing defeat of Germany, the first emphatic "No" has been spoken to this cult of universal expansion. The whole world has awakened to its senses and recorded its ancient and instinctive protest against that ultimate injustice which flows from the theory of limitless expansion in the case of nations but it has not thought of applying this to the individual.

Our little world is getting filled up and the need for the practice of restraint and the limitation of our desires increases yearly. The rapid growth in the population of Europe and its still more rapid increase in the Americas, makes self-control and self-denial increasingly necessary if social order is not to give way to anarchy.

A Whole Civilization Might Collapse in an Attempted Readjustment to New Moral Values

Nietzsche was well aware that the full and exuberant life which he preached involved a "trans-valuation of all values." But the trans-valuation of moral values is a hazardous business. It is life itself which has determined these values, and they cannot be revoked by the mere will of heralds of revolt. The values which they would revalue represent the residual experience of long ages of human life and society, during which mankind has discovered that there are certain rules of conduct which are necessary if men will live in social relations in peace and security. The trans-valuation of these old racial values has been attempted many times and always something unpleasant happened. These unpleasant happenings may be deferred for many years. They may light upon one's mother, one's family, one's children. They may affect society or posterity—but they happen.

One would think that many of our hasty writers of recent fiction and drama regard our old rules of conduct, our moral codes, as the arbitrary pronouncements of some external authority, God, or the king, or parents, or the Church. We always think of our laws as being "handed down," and we resent having our laws handed down. We want to make them. But what we forget is that we *have* made them and that it has taken centuries—ages, to do it.

The critical importance of such questions as wars between nations, the equitable distribution of wealth and opportunity, political justice toward our women, intemperance, has blinded us to other problems which affect the very existence of society, namely, social order and social stability, and physical and racial health. And since the whole world at present is in a very radical and iconoclastic mood, halting at no thorough-going change in political and social institutions, it has become vital that we shall turn our thoughts to these other problems.

What are to be the elements of order, the centripetal forces in the new society? The forces working toward chaos and anarchy are many. Any newspaper page reveals them. The intense individualism inherent in all modern thought, the disintegration of states and of old established political programs, the constantly growing lack of respect and reverence for old institutions, in fact the suspicion of anything that is old and established, the powerful influence of modern fiction

and the modern drama, the loss of the religious faith with which our moral sanctions have been closely associated, and the pragmatic philosophies of all kinds that rule in the present—these are some of the forces working against social integration.

This is not to say that any of the old ideas or these old institutions are perfect, or holy, or even good. It is only that the obedience to laws, the restraint and self-control which are necessary for social order, have been in the human brain associated with these things. A wholly new set of motives for social order is perhaps conceivable, resting upon none of these old institutions, but the human brain changes slowly, and an entire civilization might collapse in the process of a crude and reckless attempt at readjustment.

The disintegrating forces in society are many, and apparently increasing. It is necessary, if our civilization is to be saved, to turn our attention very seriously, and at once, to the integrating forces, to the forces which look to social stability, to law and order.

In the past there have been three great institutions which have acted as powerful forces of integration—the State, the Church, and the Family—the integrating power of these institutions depending not merely on external sanctions, but on the powerful motive of personal loyalty and allegiance. Since in the new society we have probably to look forward to the constantly decreasing authority of these three institutions, it is of the gravest importance to inquire what is to take their place.

In particular we must inquire what is to take the place of nationalism in the new order. When the state is small and its emblems are ever present to the senses, or when it is unified by art and religion, as in ancient Athens, or when the very existence of the state is threatened by rival states, as in the recent war, then social integration within the state is relatively perfect. Then the group spirit, the community spirit, keeps the group itself a healthy organic unit, the members of the group all loyally, willingly, eagerly performing severally their proper functions. Then justice prevails within the group, laws are obeyed and order is preserved. A League of Nations, to prevent that form of social suicide which a modern war has become, seems, as it truly is, a great step forward in human progress, but in the long history of human development social integration and social order within a state have depended to a large extent on the menace of danger to the state from without. When that menace shall be withdrawn, social integration within each state will be increasingly difficult.

The spirit of nationalism at the moment, to be sure, burns brightly, but the whole trend of the time is toward internationalism, due to the community of world interests in international labor movements, international commerce, banking, science and education.

The trend of events, therefore, forces us to believe that loyalty neither to the state, nor to the church, nor to the family, is going to be a powerful integrating force in the new society. The vital things now are labor unions, workingmen's councils, women's federated clubs, manufacturers' unions, trusts, and combinations, and countless other self-protective organizations and combinations of every sort. The old loyalty to the state and the church and the family has been in large measure replaced by loyalty to these countless social groups; but unfortunately there is no promise that loyalty to these groups is going to be in any sense a principle of social integration. On the contrary, it appears often to be a source of social strife.

The discussion of this problem in its positive aspects does not lie within the purpose of this article. Possibly a solution is not to be found in any political, economic, or social readjustments, but only in a change in human ideals.

American Indian Poetry

By HERBERT J. SPINDEN

THE myths and songs of the American Indians are part of our national heritage along with the hills and plains that were wrested from their creators. These pieces of unwritten literature, first transcribed into strange hooks and symbols by ethnologists and then translated into direct and unvarnished English, are sources of inspiration for our poets as potential as the Mabinogion or the tales of Merlin in the literature of Wales and England. They are products of the environment that we have made our own and they express deep human feelings in relation to that environment.

When Longfellow wrote Hiawatha he took the name and character of his hero from the Iroquois, the incidents of his story from the myths of the Ojibwa, and he cast these materials into the poetic mold of the Norse saga of the Old World. But writers of today are prepared to keep closer to the sources and to consult native pieces in translation. In a recently published book[1] we find an interesting anthology of American Indian poetry and a presentation of "interpretations" in the spirit of this poetry. While this book presents much that is new to the public, it leaves unvisited many pleasant fields known to special seekers.

There are tender or tremendous pictures drawn in the simple words of many Indian poems. For instance there is something we understand in this one:

> The Sioux women
> pass to and fro wailing
> as they gather up
> their wounded men
> The voice of their weeping
> comes back to us.

But it is something of a shock to be told that this is not a Song of Compassion, but a Hymn of Hate. More appealing to us in its psychology is this song of love-hurt that comes from the same tribe:

> Although he said it
> still
> I am filled with longing
> When I think of him.

Or this from the Northwest Coast:

> My child says:
> Look around at the waves,—
> Then she fools me
> with unripe salmon-berries.

Or this from the Kiowa of the open spaces where the winds ride with loosened rein at night:

> That wind, that wind
> Shakes my tipi, shakes my tipi,
> And sings a song for me,
> And sings a song for me.

And what a striking phrase is contained in the following Navaho song to the magpie:

> The Magpie! The Magpie! Here underneath
> In the white of his wings are the footsteps
> of morning.
> It dawns! It dawns!

The simple and direct matter contained in the poems quoted above does not offer great difficulties in translation. Even more sustained efforts like the following passage from the *Iroquois Book of Rites*[2] can be rendered in a natural and straightforward manner, although the construction of English varies widely from that of Iroquois, as may be seen at a glance. The translation runs exactly across from line to line:

[1] George W. Cronyn, Editor. *The Path On the Rainbow.* An anthology of songs and chants from the Indians of North America. Boni and Liveright, New York, 1918.

[2] Horatio Hale, *The Iroquois Book of Rites* (Brinton's Library of Aboriginal American Literature. Number II.), p. 153. Philadelphia, 1883.

Haihhaih!	Woe! woe!
Jiyathontek!	Hearken ye!
Niyonkha!	We are diminished!
Haihhaih!	Woe! woe!
Tejoskawayenton.	The cleared land has become a thicket.
Haihhaih!	Woe! woe!
Skahentakenyon.	The clear places are deserted.
Hai!	Woe!
Shatyherarta—	They are in their graves—
Hotyiwisahongwe—	They who established it—
Hai!	Woe!
Kayaneengoha.	The great League.
Netikenen honen	Yet they declared
Nene kenyoiwatatye—	It should endure—
Kayaneengowane.	The great League.
Hai!	Woe!
Wakaiwakayonnheha.	Their work has grown old.
Hai!	Woe!
Netho watyongwententhe.	Thus we are become miserable.

There is a class of Indian compositions midway between the emotional outburst of the short songs and the long ceremonial pieces that are blocks in a great philosophical structure. Among the Eskimo, for instance, we find colloquial poems full of excellent character drawing and understandable humor. It would be difficult to improve upon the matter of these verses in which Savdlat and Pulangit-Sissok pay their respects to each other in terms of raillery.[1]

SAVDLAT SPEAKS:

The South shore, O yes, the South shore I know it;
Once I lived there and met Pulangit-Sissok,
A fat fellow who lived on halibut, O yes, I know him.
Those South-shore folks can't talk;
They don't know how to pronounce our language;
Truly they are dull fellows;
They don't even talk alike;
Some have one accent, some another;
Nobody can understand them;
They can scarcely understand each other.

PULANGIT-SISSOK SPEAKS:

O yes, Savdlat and I are old acquaintances;
He wished me extremely well at times;
Once I know he wished I was the best boatman on the shore;
It was a rough day and I in mercy took his boat in tow;
Ha! ha! Savdlat, thou didst cry most pitiful;
Thou wast awfully afeared;
In truth, thou wast nearly upset;
And hadst to keep hold of my boat strings,
And give me part of thy load.
O yes, Savdlat and I are old acquaintances.

Very different in feeling but of equal merit as a sustained effort is a love poem of the Tewa Indians of New Mexico.[2]

My little breath, under the willows by the water side we used to sit
And there the yellow cottonwood bird came and sang.
That I remember and therefore I weep.
Under the growing corn we used to sit,
And there the little leaf bird came and sang.
That I remember and therefore I weep.
There on the meadow of yellow flowers we used to walk
Oh, my little breath! Oh, my little heart!
There on the meadow of blue flowers we used to walk.
Alas! how long ago that we two walked in that pleasant way.
Then everything was happy, but, alas! how long ago.
There on the meadow of crimson flowers we used to walk.
Oh, my little breath, now I go there alone in sorrow.

The religious poems that are found especially well developed among the Pawnee, the Navaho, and the Pueblo tribes of the Southwest may have been inspired, in part at least, by the ancient literary products of Mexico and Central America. Unfortunately the anthology

[1] D. G. Brinton. American Aboriginal Poetry (*Proceedings, Numismatic and Antiquarian Society of Philadelphia*, 1887–1889), pp. 21–22.

[2] H. J. Spinden, Home Songs of the Tewa Indians (AMERICAN MUSEUM JOURNAL, Vol. XV, February, 1915), p. 78.

before us gives no examples of Aztecan or Mayan poetry and only one piece from Peru.

I will therefore sketch briefly the best products of literature in these regions where something close to the drama was developed in connection with spectacular ceremonies and where specially composed verses were recited on occasions of great rejoicing or solemnity. To begin with Peru, there are names for four different sorts of plays among the Incas, covering the range from tragedy to farce. Sir Clements Markham has given us the Inca drama of *Apu Ollantay* in two states, literal and literary. But this drama is so much like the drama of Europe in form that doubts have been cast on its authenticity. It surely contains native material, modified somewhat by European influences. In one scene the chorus sings the following harvest song that has an allegorical reference to the love plot in the play. Tuyallay—my little tuya—is the name of a small finch, and Ñusta means princess.[1]

Thou must not feed,
O *Tuyallay,*
In Ñusta's field,
O *Tuyallay,*
Thou must not rob,
O *Tuyallay,*
The harvest maize,
O *Tuyallay,*
The grains are white,
O *Tuyallay,*
So sweet for food,
O *Tuyallay,*
The fruit is sweet,
O *Tuyallay,*
The leaves are green
O *Tuyallay,*
But the trap is set,
O *Tuyallay.*
The lime is there,
O *Tuyallay.*

We'll cut thy claws,
O *Tuyallay,*
To seize thee quick,
O *Tuyallay,*
Ask *Piscaca,*
O *Tuyallay,*
Nailed on a branch,
O *Tuyallay,*
Where is her heart,
O *Tuyallay?*
Where her plumes,
O *Tuyallay?*
She is cut up,
O *Tuyallay,*
For stealing grain,
O *Tuyallay.*
See the fate,
O *Tuyallay,*
Of robber birds,
O *Tuyallay.*

More ponderous and impressive are hymns to Uira-cocha, the unknowable, all-powerful and ever-benevolent Supreme Being of the Incas. I quote[2] but a portion of one of these:

O Uira-cocha! Lord of the universe,
Whether thou art male,
Whether thou art female,
Lord of reproduction,
Whatsoever thou mayest be,
O Lord of divination,
Where art thou?
Thou mayest be above,
Thou mayest be below,
Or perhaps around
Thy splendid throne and sceptre.
Oh hear me!
From the sky above,
In which thou mayest be,
From the sea beneath,
In which thou mayest be,
Creator of the world,
Maker of all men;
Lord of all Lords,
My eyes fail me
For longing to see thee;
For the sole desire to know thee.

The literary remains from Central America are scanty, especially those containing verse. Bishop Landa tells us that in northern Yucatan dramatic representations took place on prepared stages or platforms. In Mayan cities that flourished in the fifth and sixth centuries A.D. we find the ruined remains of courts surrounded by stepped walls. These probably served as amphitheaters.

Of the poems recited by the Aztecs on gala occasions we have fragments that make us realize the world's loss in the destruction of this literature.[3] The

[1] Sir Clements Markham, *The Incas of Peru*, pp. 353–354. New York, 1910.

[2] Idem, p. 100.

[3] Daniel G. Brinton, *Ancient Nahuatl Poetry* (Brinton's Library of Aboriginal American Literature, Number VII.) Philadelphia, 1887.

sixty songs of King Nezahualcoyotl were held by the Aztecs as examples of the poetic art at its best. They admirably expressed the philosophy of eat, drink, and be merry. Nezahualcoyotl is addressed in these words by a brother poet:

And thou, beloved companion, enjoy the beauty of these flowers, rejoice with me, cast out fears, for if pleasure ends with life, so also does pain.

A responsibility above mere pleasure was recognized, however, in subsequent lines, and a permanence for good deeds as contrasted with human vanities.

I fear no oblivion for thy just deeds, standing as thou dost in thy place appointed by the Supreme Lord of All, who governs all things.

Poetry was flowery speech to the Aztecs and the symbolism of flowers is repeated in lovely phrases. For instance:

Weeping, I, the singer, weave my song of flowers of sadness . . .

I array myself with the jewels of saddest flowers; in my hands are the weeping flowers of war; I lift my voice in sad songs; I offer a new and worthy song which is beautiful and melodious; I weave songs fresh as the dew of flowers . . .

Let my soul be draped in various flowers; let it be intoxicated by them . . .

The divine flowers of dawn blossom forth . . .

O youths, here there are skilled men in the flowers of shields, in the flowers of the pendent eagle plumes, the yellow flowers which they grasp; they pour forth noble songs, noble flowers; they make payment with their blood, with their bare breasts; they seek the bloody field of war. And you, O friends, put on your black paint, for war, for the path of victory; let us lay hands on our shields, and raise aloft our strength and courage.

The religious chants preserved by Sahagun are written in archaic Nahuatl. The phrases must have sounded as strangely in the ears of the common Indian of those days as the verses of Chaucer do in our ears today—perhaps more so. Even when carefully translated these chants are unintelligible to persons ignorant of Aztecan beliefs and usages. Therefore I have found it wise to follow this chant with a fairly detailed explanation.

SONG OF THE YELLOW-FACED ONE[1]

I.

In Tzommolco, my fathers, shall I affront you?
In Tetemocan shall I affront you?

II.

In the temple of Mecatlan, O, my Lords, the yucca tree booms.
In Chiueyocan, the House of Disguises, the masquerade has come down.

III.

In Tzommolco they have begun to sing
In Tzommolco they have begun to sing
Why come they not hither
Why come they not hither.

IV.

In Tzommolco human beings shall be given
The Sun has come up!
Human beings shall be given.

V.

In Tzommolco now ceases the song
Without effort he has grown rich, to lordship he has attained,
It is miraculous, his being pardoned.

VI.

O little woman utter the speech
Lady of the House of Mist utter the speech abroad.

[1] Eduard Seler, *Die religiösen Gesänge der alten Mexikaner.*

Commentary.—I. The "Yellow-Faced One" is a descriptive name of the Fire God who had many other names. Tzommolco was a temple to this god in Tenochtitlan (Mexico City) and Tetemocan is probably a second name for the same building. The question "shall I affront you" means "shall I withhold from you the prescribed sacrifice." It is a formula that is often used. The plural "my fathers" may have been addressed to the several priests in charge of the ceremony who were regarded as representatives and impersonators of the god.

II. Mecatlan was possibly a temple of music; at any rate the "yucca tree booms" refers to the beating of the drums which were made of the hollow trunk of the yucca. The next name, Chiueyocan, may be translated "Place of Eight-ness,"—but even then the term is cryptic enough. It was possibly a temple where dancers donned their animal masks and other ceremonial regalia.

III. and IV. These stanzas relate the progression of the ceremony and call the priests to a sacrificial rite with human victims. The Fire God appears to have been the same as the Sun God and the sacrifice was made at sunrise.

V. These words refer to the rewards given by the Fire God to the person on whose vow or petition the ceremony had been called. This divinity was also God of Wealth and Honors. He was pleased by worship and he heaped sudden wealth and high rank upon his worshipers.

VI. The last stanza doubtless has some esoteric connection with the preceding stanzas. The person referred to is possibly a mountain goddess connected in some mythical way with the Fire God. Possibly she is requested to herald his fame and powers.

This Aztecan chant takes up events in succession and gives enough detail to indicate this succession to anyone familiar with the words and the religious background. It must be evident to the reader that the feeling of mystery and illusion gained from the first perusal largely disappears when we are in possession of even a portion of the facts and formulæ known to the creators. In the absence of this knowledge we get an emotional reaction, it is true. Our intelligence, that naturally strives to make sense out of words, is teased and thwarted.

The religious poems of the Pueblo Indians, of the Navaho, Pawnee, and Omaha, are filled with formulæ and with more or less esoteric and priestly phrases that the Indians call "high words." For instance, the repetition of a prayer to the four directions and to the above and the below is a formula of universality. The association with these world points of special colors, hunting animals, game animals, birds, etc., is a pictographic device probably taken over by the northern tribes from the highly developed cosmology of Mexico. The greater gods of the northern Indians lack, in general, the definite characterizations that we find in Mexico. They are formless powers that move in clouds and floods. But there are lesser gods who are commonly personifications of animals, plants, etc. Of course, the names of these gods can never have associations for us of the same sort that they do for the original Americans.

Indian invocations often carry a dreadful sincerity and give a sense of impending divinity. The argument is consistently made through objective reality to subjective ideality. Note how the Sia appeal through the eye and ear to the reasoning mind that would know the Makers of Storms:

Cover my earth mother four times with many flowers.
Let the heavens be covered with the banked up clouds.
Let the earth be covered with fog; cover the earth with rains.
Great waters, rains, cover the earth.
Lightning cover the earth.
Let thunder be heard over the earth; let thunder be heard;
Let thunder be heard over the six regions of the earth.

To these Indians the æsthetic arts are useful and filled with magic. Their songs are prayers for rain as are likewise the designs they paint on pottery or weave on cloth. They live immersed in beauty, but it is the beauty that does, not the beauty that seems. While the Navaho god created he sang as follows:

In old age wandering on the trail of beauty.
For them I make.
To form them fair, for them I labor.
For them I make.

In these words is expressed the philosophy that beauty is truth and perfection in use and being.

The question soon asked by a person skilled in the use of words on reading American Indian verse is this: "How much of the effect is real and how much is adventitious?" Someone has somewhere observed that when you learn a new language you acquire a new soul. Words are not merely the carriers of thought, they are also to a large extent the molds of thought. New sets of words involve new ways of thinking because they establish new associations between objects and ideas. Literal translation may put into the language of the second part some original quality of the language of the first part, but more often it puts in a new and picturesque something that comes from mere contrast between two systems of word order and word association.

Language makes possible the transference of ideas from one human mind to another only because articulated sounds—or graphic symbols that substitute for them in writing—rest upon a social basis of common acceptance for the word and common experience for the meaning. But just as the art of

weaving varies from one place to another because tools, materials, and ideas of construction vary, so the art of presenting thought in sounds or preserving it in sound symbols, is modified and limited by the mechanical possibilities and suggestions inherent in the particular language. Textile design, properly speaking, must follow the lines of construction. Poetry is design in words and in any particular language it must also adjust itself to construction. The device of rhyme, for instance, is not always possible. Rhythm of one kind or another is usually present because primitive poems are usually sung. Accent is common in polysyllabic languages but the primitive singer does not hold himself strictly to these accents. Syllables may be slurred, lengthened, reduplicated, etc., to meet the requirements of the singing voice. Repetition often gives rise to stanza forms especially when there is an orderly variation combined with the repetition. Thus in an extempore song of virtues in a funeral ceremony a qualifying phrase may vary between set phrases. For example:

> She is dead, *the generous one*,
> My daughter is dead, dead!
>
> She is dead, *the loving one*,
> My daughter is dead, dead!

In the translation of poetry there are the prose and the poetical methods. The prose method is to translate simply the thought, and the natural tendency of the followers of this method is to translate the thought into English which is devoid of any emotional quality. The poetic method is to translate the thought as directly as possible into words of emotional quality. The difficulty with this method is that it is hard to match emotional qualities between languages. Moreover, the persons who naturally prefer it have subjective rather than objective interests. American Indian languages are rich in terms that single out details of the outside world and in classifications of the states of matter but they are weak in words that present or qualify the subjective world and the states of mind. Yet, far from being materialistic, the Indians recognized a persistent duality in nature and each thing had its soul.

Some anthropologists, especially Frank Cushing, Alice Fletcher, Washington Matthews, and Jeremiah Curtin, have treated Indian songs and myths in literary fashion. But they have worked from native texts and so have not gone far astray on the fundamental meanings of the original words. The criticism of their translations lies not so much in denotation as connotation. An English word may have approximately the same meaning as an Indian word and yet have entirely different associations. They have given a poetic quality where there should be a poetic quality—but perhaps they have endowed the rose with the fragrance of the violet.

When it comes to a second remove such as is seen in the "interpretation" of Indian verse we are on still more doubtful ground. Even the most pretentious interpreters of Indian modes of thought make mistakes. For instance, one might place greater faith in the emotional and intuitive judgments of Mary Austin if the poem chosen by her to represent the quintessence of Indian art were not a flagrant fraud long since exposed. The epithalamium of Tiakens was written by a French student of languages named Parisot when scarcely twenty years of age. The daring youth fabricated the grammar, vocabulary, and texts of a language which he declared to be that of the now extinct Taensa tribe and was successful in deceiving the world for several years.

Of course what the interpreters want are new themes and freshened expressions. They can get these by imitating the objectivity of Indian poetry that pictures causes and circumstances and

lets the mind of the hearer or reader interpret for itself. Sometimes the word association or the sentence structure in a foreign language can be transferred legitimately into English. For instance, in a song given above let us take the Tewa terms *p'in'e* and *hâ'e*, the diminutive forms of *p'in* and *hâ*, that mean "heart" and "breath." These terms of endearment are different from the ones we use in English but are understandable because we ourselves make use of the affectionate diminutive (as in little mother, motherkin, etc.) and we associate the heart and the breath with love and life. The exotic quality that exhales from Burton's translation of the *Arabian Nights' Entertainments* is partly due to peculiar similes and recurring phrases that strike forcibly upon our western imaginations. To eastern readers these are conventions pure and simple and the signs of real excellence something entirely different.

A translation that is first and last the carrying over of a thought and all its associations from one language to another, is essentially a new creation. A human mind must intervene and receive the terms and construction of the language of the first part and give out not the form but the content of the message in terms and constructions of the language of the second part. Poets who attain the grotesque by half translations make an unfair use of Indian verses.

Constance Lindsay Skinner, in the terminal essay to *The Path On the Rainbow*, unconsciously makes clear that her reaction to Indian verse is involved and subjective and that she sees only through the eyes of the English language albeit sympathetically. She says: "The Indian water-song is poetry to me because of a memory:—an old chief, his hair grayed and his broad brown face deep-lined by a hundred and ten years, his sightless eyes—almost hidden under sagging, crinkled lids—raised to the wet air." After all it is the subjective of our own culture rather than the subjective of Indian culture that is stirred by Indian poems.

I believe that the study of primitive American poetry should have a wholesome and stimulating effect upon modern American literature. It is open, sincere, and inspiring, and it has an engaging quality of directness and simplicity.

There is today, however, a pseudo-primitive school that in painting, sculpture, music, dancing, and poetry affects the mold but ignores the content of art that is genuinely primitive. The work of this school lacks communal acceptance, undivided purpose, and innate sincerity, and is essentially individualistic and revolutionary. Nevertheless, good may come out of such efforts if only the public learn sufficient discrimination to select gold from dross. Real primitive art has behind it a tradition of untold centuries while pseudo-primitive art can boast only a doubtful present. If a choice were to be made between the atavistic muse of Dr. Frank Gordon that sings:

By south-way, east-way, shore-land place,
Men come,
Boats come,
Float fast,
Handsome.
Man-who-Paints, much-talker, he much-walked
Easterly, south also,
All-time stalked— . . .

and the untutored savage of the Painted Desert whose immemorial gods of cloud and bush have taught him to say:

May their roads home be on the trail of peace,
Happily may they all return.
In beauty I walk,
With beauty before me, I walk,
With beauty behind me, I walk,
With beauty above and about me, I walk,
It is finished in beauty,
It is finished in beauty.

What would the verdict be?

A NUT PALM BESIDE THE JUNGLE TRAIL

The nut palm is one of the most common of Panamanian palms. About every fifth palm has a family of opossums occupying the hollow center where the branches start. The photograph also shows typical second growth jungle about as high as it ever gets

Unknown Panama[1]

By TOWNSEND WHELEN

Lieutenant Colonel, United States Army

I BELIEVE it will surprise most Americans, and perhaps a few of our field naturalists, to learn that right at the back door of the Panama Canal lies an almost unknown jungle wilderness, unmapped and practically uninhabited in the interior except for a few very primitive Indians. Virtually the entire eastern portion of the republic of Panama lying between the Canal and Colombia, roughly three hundred miles long by from fifty to one hundred miles wide, is unknown, and the published maps of this country, except for the seacoast and the location of half a dozen small towns, are all faked.

It was my good fortune to spend the entire dry seasons (December to June) of 1916 and 1917 exploring a part of this country. We found it necessary to know something of that portion of it nearest the Canal, and it fell to my lot, assisted by Companies E and H, 29th United States Infantry, to make a preliminary exploration with a view to planning and expediting its accurate mapping by the Engineer Corps.

The coasts of Panama are all accurately charted. In the vicinity of the city of Panama are a few fair-sized towns on the larger rivers, and their location, as well as the general course of the rivers on which they lie, is indicated with fair accuracy on existing maps. Some of the mountain ranges which can be seen from the sea have also been set down. The remainder is unknown. Moreover, it will of necessity remain so. The Panamanian is not a pioneer. Exploration does not appeal to him and, in fact, he dreads the jungle at his back door. No guides to this country can be procured. The Indians of the interior are hostile to the invasion of the country by the whites. There are no roads or trails, and practically no navigable rivers, back packing being the only practical means of transportation. Even maps are not available, and probably it will be very many years before they become so, owing to the necessarily confidential nature of such accurate maps as exist, because of their connection with the defense of the Panama Canal.

It is because this little piece of jungle probably will remain virgin and unspoiled for many years that I think it ought to be brought to the attention of our field naturalists. It is so easily accessible, and yet only the borders of it have been scratched by the scientist. No one yet knows what is in the interior, what secrets it contains, what new fauna and flora its exploration will reveal.

In the Canal Zone, which extends five miles to either side of the Canal, practically all of the jungle forest has long since been cut off, and in its place has grown up a dense, impenetrable second growth of small trees, palms, creepers, thorns, and coarse grass. The casual visitor to the Canal never sees the real jungle, nor dreams of its existence. In fact not 5 per cent of the inhabitants of the Canal Zone and the cities near by have ever seen the virgin jungle. To them the second growth is the jungle, uninteresting, impossible, terrifying.

But if one cuts his way through this tangled growth for about five miles in from the Canal he comes to the real jungle, standing up like a gigantic wall of green verdure. Once in it all is different, even the very climate itself.

[1] The illustrations are from photographs by the Author.

Here one can wander at will, unimpeded by thorns and creepers. It is even easier traveling here than in the woods of our own Northeast, because as a rule there is much less "down" timber. It is like a new world, a world that one has not even read about. From the blazing sun and sweltering heat of the second growth one enters what is almost an underground world, cool and balmy. Everywhere the giant trees go up limbless for from one hundred to two hundred feet, and then spread out their verdure, literally hiding the sky. Beautiful slender palms grow in great profusion in the semi-darkness forming the lower growth, impeding one's view but not one's progress. Scarcely ever can one see more than fifty yards, and never does the explorer get an extended view, even from the tops of the highest mountains. When I first entered the jungle it was with an indescribable feeling of awe and wonder, and this feeling has never left me; nay, it persists, drawing me, calling me to come back, more insistent even than the "Call of the North."

That part of the jungle in which my most intensive exploration was conducted lies to the east of the city of Colon, between there and the town of Nombre de Dios, and extending from the Caribbean coast inland to the headwaters of the Chagres River system. Between the Chagres basin and the Caribbean coast rises the cordillera of Cerro Bruja, a mountain range that starts about ten miles east of Colon, and rises steadily, culminating in the peak of Cerro Bruja (3200 feet) about fifteen miles south of the town of Porto Bello. East of Cerro Bruja peak the Rio Piedras rises almost in the basin of the Chagres, flows north around the base of Cerro Bruja, then west, and empties into the sea halfway between Colon and Porto Bello. The Piedras is one of the largest rivers of Panama, but you will not find it on any map, even its mouth having been mistaken for a lagoon of the sea when the coast line was charted.

The Rio Grande, figuring largely on existing maps, is an insignificant little stream, several miles long, really unworthy of a name. Beyond the valley of the upper Piedras rises a really imposing range of mountains called Cerro Saximo, culminating in a peak somewhere south of Nombre de Dios, which must attain an altitude of from six thousand to eight thousand feet. I think I am the only one who has ever viewed this range, as it seems to be invisible from any place where there is any trace of human beings, and its presence is barely noted on only one old map, with no indication as to its altitude.

Beyond Saximo neither I nor anyone else knows what. There are rumors that the interior beyond is inhabited by Indians of the San Blas (Cuna-Cuna) tribe, and that they are very hostile to invasion of their country by whites. Today one can enter the jungle ten miles east of the city of Colon, and travel eastward through this jungle wilderness for more than three hundred miles, and except for a few marks of my machete, he will not see the trace of a civilized being.

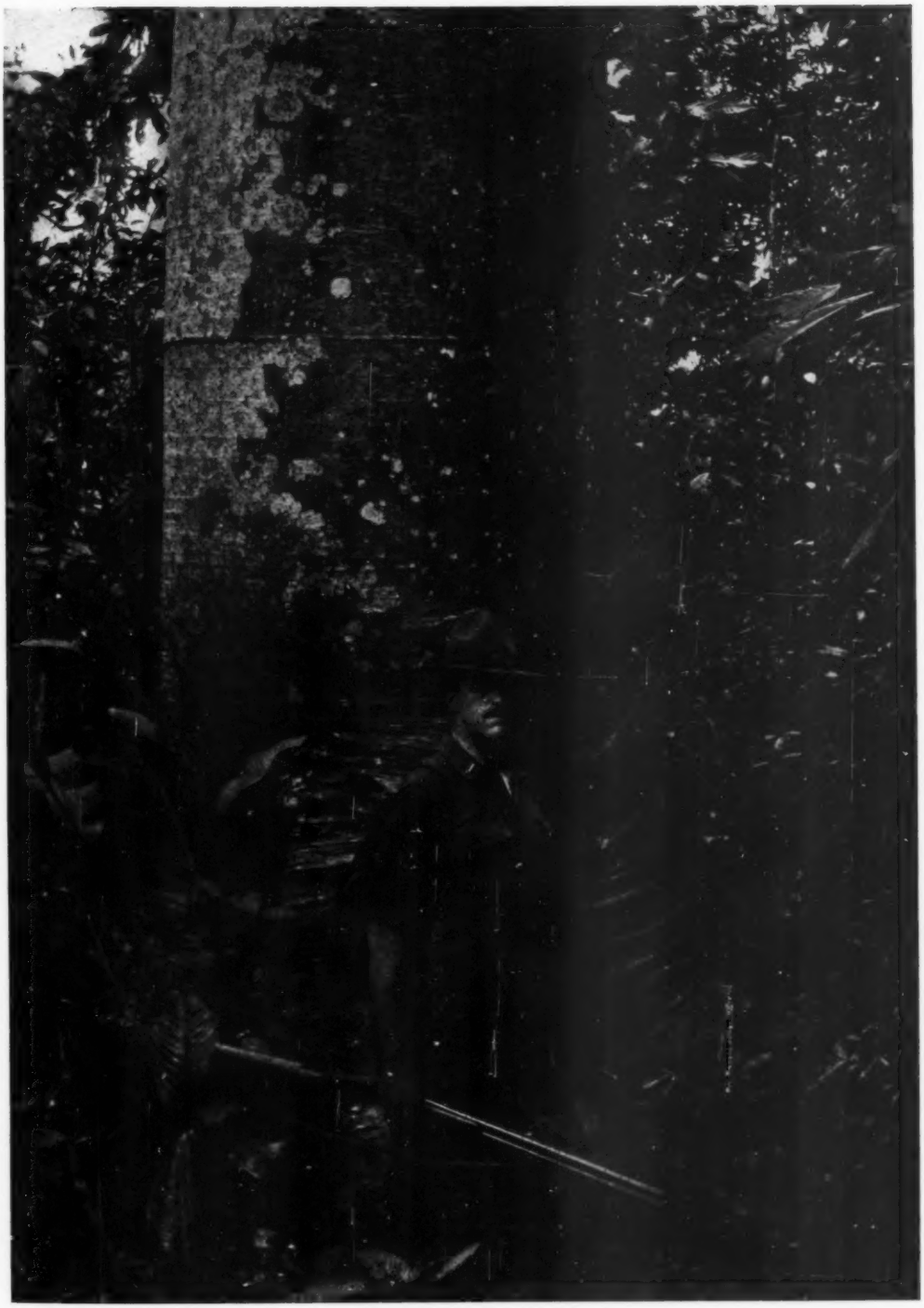
In January, 1916, I established a base camp at the end of the extreme northeastern arm of Gatun Lake, and from there extended my explorations. Trails were cut for about fifteen miles into the jungle, and other base camps were established from time to time. Sketch maps were made of the surrounding jungle, the work being done by Companies E and H, 29th United States Infantry, which companies I commanded from time to time. The extended exploration, however, could not be done in this way. The difficulties attending the supply of a large number of men in a country without trails or horse feed made the work very slow. So I was forced to fall back on the most primitive of all methods of

THE BASE CAMP OF COMPANY E, 29TH INFANTRY, ON RIO VIEJO

All the equipment was packed on the backs of the men for more than twenty miles. The jungle here was so thick that before it was cleared off we could not see more than ten feet ahead. The men's sleeping quarters are on the left. On the right are the large cheesecloth mosquito bars (12×9×7 feet) which the men used in the evenings for reading and recreation. Below 1000 feet altitude the mosquitoes are so thick at night that it is impossible to remain out of doors with any comfort, although the mosquitoes are not dangerous except where they have become infected by biting natives suffering from malaria. It was from this camp that the author started on a number of his explorations into the distant jungle

THE FIRST STEP IN MAKING A JUNGLE BED IN PANAMA

First a thick, springy mattress of palm leaves is cut (palm boughs in Panama taking the place of balsam boughs in northern woods), then the little jungle tent, with waterproof silk floor and roof and mosquito net sides, is pitched on top of the mattress, making a most comfortable bed, insect proof and cool. At every camp site there were always plenty of palms within a distance of twenty-five yards with which to make the bed



THE MOST CONSPICUOUS OF PANAMA TREES

While the Cuipo tree (*Cavanillesia platanifolia*) is not the largest of Panamanian trees, it is by far the most conspicuous. It always grows in the most prominent places and rears its head like a gigantic umbrella far above the surrounding jungle. Rings in the bark surround the trunk about every four feet, the trunk rising without a limb for one hundred and twenty feet. The buttressed trunk reminds one of a gigantic elephant leg and foot

exploration, that of small parties of four or five men, packing all their supplies on their backs, and remaining out as long as their supplies lasted, or as long as they could subsist on the country. In this manner I made a number of trips of from two weeks to a month's duration, deep into the jungle, and learned something of what was beyond the edge. We saw the jungle at its best, became familiar with it, and learned to depend on it for shelter and most of our food.

I must confess to absolute incompetency when it comes to a description of the flora of the jungle, incompetency both scientific and linguistic. I doubt if the jungle as a whole can be described—it can only be marveled at. It is beautiful, appealing, terrifying. I never cease to wonder at the trees—giant moras, borigon, cavanillesia, ceibas, rubber, and fig. The enormous trunks with great buttressed roots rise a hundred feet without a limb, and then spread out literally to hide the sky. Limbs, so high that one can scarcely see them among the leaves, drop lianas to the ground—long tangled lines like the wrecked rigging of some masted ship. Then there is the secondary growth, a hundred varieties of tree ferns and palms, suited by nature to grow in semidarkness, robbed of the sunlight by their giant neighbors.

One of the things to beware of in jungle travel.—The black palm is a common tree in the virgin jungle of Panama. The thorns which cover it are very sharp, and the newcomer in the jungle invariably receives many painful wounds from it before he learns to look first instinctively when about to lay his hands on small trees to push them aside as he walks through the jungle. The wood of the black palm is very beautifully colored in alternate longitudinal layers of black and white, and is much in demand for canes

Between my first and second year of exploring, I came north in desperation and appealed to the Smithsonian Institution[1] at Washington for some knowledge of the flora of this region. The reply I received was discouraging, and yet should be an incentive to every botanist and naturalist: "One man could spend a lifetime studying the flora of that jungle, and then not know it; more than 80 per cent of the jungle growth in Panama is unknown to science."

My ignorance of the flora extends also to the fauna, except that from many years of wilderness loafing and big game hunting in the North I have naturally come to a sort of practical method of study all my own, and have learned to observe with some little truth, but with very little science. In fact, except temperamentally and physically, I was in no manner equipped for a scientific study. Nor with my many military duties connected with

[1] To Professor Henry Pittier, who probably knows this jungle more intimately than does any other scientist, having spent many years of field study in Costa Rica, and who has actually taken one trip into the very country in which I was working.

exploration, mapping, and the management and supply of my men, was I able to devote much time to natural history. The first year I was totally unprepared. The second year I went better equipped from a scientific point of view, and I believe I made a collection of specimens, notes, sketches, and photographs that might have been of some little value, but unfortunately these were all lost by the capsizing of my cayuca a mile out at sea when returning from my longest expedition.[1] Right here I cannot refrain from intruding a word of caution to men inexperienced in jungle field work. Put not too much faith in the waterproof qualities of canvas bags or the tin containers provided for waterproofing photographic films. Avoid the dug-out cayucas, particularly those with little freeboard, when traveling with precious material. Put no trust in the native judgment.

The bird life is no less wonderful than the vegetation. The Panama jungle is alive with birds. The variety and coloring are truly remarkable. Even before I had begun to read anything on tropical birds I had noticed the remarkable restriction of the activities of certain birds to certain areas or "zones" of the jungle. In the region where I did most of my work there seemed to be three areas of bird life dependent on the altitude, and three or more dependent upon the jungle construction. In addition to these there is what we may call the second-growth area, the birds in this being seldom seen in the virgin jungle. As regards altitude there are the sea-level or low-country area, the two-thousand-foot area, and the area above three thousand feet.

As regards the jungle at any point we can distinguish four areas, which we may designate as the ground, the low-bush, the medium, and the tree-top. On the ground I observed several varieties of quail, tinamou, and pheasants. In the low-bush area are wrens, humming birds, thrushes, ant birds, and a variety of other species either common to the United States or unknown to me. In the medium zone, halfway to the leafy ceiling of the jungle, dwell doves, guans, owls, motmots, and trogans. High up in the roof are parrots, parrakeets, macaws, toucans, and cotingas.

Many birds seen in large numbers in

Young peccary captured from a herd of about forty in the Cerro Bruja Mountains.—After capture this little animal was kept in a cage for five days, when it managed to escape. We thought it gone for good, but several hours afterward it came back to the kitchen and grunted to be fed. Thereafter it could not be driven away from the kitchen, and was the inseparable companion of one of the cooks. It was living and in good condition six months after capture

[1] When we emerged from the jungle we were away down the Caribbean coast near the San Blas Indian country. With a couple of natives and a large dugout canoe I started to cruise up the coast to Colon. A few hours after we started we encountered rough seas off a point of land and the canoe was swamped, spilling us all out in the ocean, which was infested with sharks. Fortunately no men were lost and we were blown ashore finally on a practically uninhabited coast. But I did lose all my outfit except a little pack which contained my maps, films, and camera. The camera was totally ruined, and although all the exposed films were in so-called waterproof cans, they filled with salt water and all the photographs were spoiled.

the low countries we found absent at high altitudes. I never saw guans below one thousand feet, nor toucans above that altitude. The yellow and black orioles build their hanging nests everywhere in the low country but they were not seen in the mountains. Please understand that what I write should not be taken as establishing anything. The time for observation was too short, and my own observations, while I think they were accurate, were not based on scientific study. What I want to point out, in fact the whole reason why I have undertaken this sketchy description of the Panama jungle, is that I believe the region is very worthy of intensive study by a first-class field naturalist. Particularly that very high part to the south of Nombre de Dios should be investigated, as it may be found to contain new forms, or to mark a northern limit of some forms hitherto believed to be confined to the Andean regions.

The mammal life of the jungle is also very abundant. The ordinary traveler, however, will see little of it owing to several conditions which only a man with extensive hunting or collecting experience will realize. The constantly shifting winds of the jungle carry one's scent far and wide. The rustling of the vegetation and other noises as one walks, alarm the game. Moreover, everywhere in the jungle are sparks of bright light, the result of the filtering of the intense tropical sunlight through small openings in the leafy roof overhead. These sun patches sparkle like diamonds everywhere. I think that the game watches these patches and is particularly alarmed when they are hidden by sudden shadow. At any rate, when I began to avoid these sunny spots, and to take

The jungle is entirely uninhabited except for a few natives who live on the Caribbean coast and never venture into the interior. They subsist on coconuts, bananas, yams, and fish. They gather ivory nuts, raise bananas, and make charcoal for a living, selling their produce to small sailing vessels which visit the villages every three months or so. They are expert canoe men and their cayucas are works of art. The coast cayuca always has a turned up bow and stern and is equipped with a small sail. Invariably these natives of the coast have not the slightest knowledge of any of the country other than the route to the next village

extraordinary precautions as to wind and noise, I began to see animals. Among those I observed were tapir, deer, peccary, agouti, paca, sloth, coati-mundi, kinkajou, anteaters, monkeys, otter, puma, jaguar (spotted and black), ocelot, squirrels, opossums of many varieties, and rabbits.

Snakes were fairly numerous, the harlequin snake, boa constrictors, and a very long and thin bright green tree snake being the most numerous. In the two years I observed only two fer-de-lance. It is said the bush master is met with occasionally, but I have never seen one. The snakes are most decidedly not a menace. In the fifteen years of American occupation of the Canal Zone the hospital records include only one case of snake bite. In fact, practically the only dangers attending jungle exploration are those of malaria and getting lost, added to injuries that may come from falling limbs and nuts.

One night in permanent camp a limb fell on my cook shack where the three company cooks were sleeping, breaking the cots of the men, and pinning them down to the ground, but fortunately not injuring any of them severely. I made the remark after the accident that that was probably the safest place in the whole jungle now. Afterward, we abandoned this camp for about a month, and on our return discovered that the same shack had again been completely wrecked by an enormous fallen limb.

There is one tree which bears a green nut about the size and shape of a football, and weighing seven or eight pounds. I have frequently noted nuts of this kind, that in falling to the ground have buried themselves three or four inches below the level of the earth. A blow on the head from one of them might easily kill a man. Monkeys feed on them, gnawing a circular opening about three inches in diameter through one end of the shell, and then removing the contents with their hands. The hollow vessel thus formed makes a most interesting and convenient water jug or vase.

I cannot say that the dangers of the jungle ever caused me any loss of sleep. I do not believe they are any greater than the dangers of our own Canadian woods, certainly not as great as the dangers of our Rockies, and far less than the dangers of a modern city street.

I was always interested in the impression that the jungle seemed to make on my men. For my long trips I always selected men having the characteristics of the pioneer—ability to travel without getting lost, physique capable of hard work including heavy packing, love for hunting, and a knowledge of camping and woodcraft. Splendid men they were, every one of them. They enjoyed the work, just as any red-blooded young man would enjoy a camping trip in the woods. But there always came, after a time, a difference in the way they regarded the jungle, and this difference in attitude always came at the same corresponding time, three or four days in from civilization. It would be just at dusk, camp made, the little mosquito-proof tents up, supper cooking, and the hush of evening started. Then far off would begin, "Wough, wough, wough, O wough-h-h, wough, wough," booming from hill to hill, resounding through the whole jungle, terrifying, paralyzing at first until one knows what it is. It is seemingly the howl of some large wild beast, but in reality it is the call of the howler monkey. It is typical of the jungle, speaking at once of jungle peace and jungle war. From the time that my men would first hear this call, they would regard the jungle differently. They were now of the jungle, they had felt its spell, they were coming back; the call of the jungle was in their blood never to leave. And so some day, God willing, I too shall go back, just as I do now in memory.

NATIVE HUTS OF PANAMA ON THE AGUA CLARA

The photograph clearly shows the banana plantation of the natives, with the second growth trying to choke it out, and beyond, the wall of the virgin jungle. There is always this clear demarcation between the second growth and the virgin forest, as clearly defined as the difference between a cornfield and heavy woods on a farm "down East." Sometimes for many days we were confined to wading the rivers, there being no other way of getting through the country

A VIEW ABOVE THE JUNGLE OF PANAMA

It is seldom that one gets an extended view such as this in the virgin jungle. Even from the tops of high mountains one cannot see more than twenty-five yards or so until a vista has been cut, and this often requires many hours' labor by good axmen. On the near hilltop to the left may be seen the top of one of the wonderful cavanillesia trees (see page 313) which are quite common on the Pacific side of the Isthmus, but seldom seen on the Atlantic side

IGUANAS BASKING IN TROPICAL SUNSHINE

These lizards (*Iguana tuberculata*) frequent the banks of all the lakes and pools, and can be seen sunning themselves on the limbs of trees overhanging the water. If disturbed they usually jump into the water, no matter what the height of the limb. When an iguana six feet long jumps one hundred feet into a still pool, the splash can be heard for a mile. Occasionally an iguana will endeavor to hide by circling the limb like a squirrel. This lizard is extremely good eating, the flesh tasting like tender chicken. It reaches a maximum length of six feet, two thirds of which is tail

NEAR THE SOURCE OF THE RIO PIEDRAS, IN UNKNOWN PANAMA

This is one of the largest rivers of the Republic but it was unknown and unmapped before discovered by the Author. Eleven days were spent wading this river from source to mouth without seeing a single habitation, or a sign of human being until within a mile of the sea. As a rule the jungle on the bank was so thick that the party was compelled to wade all day long. Fish, in appearance like shad, and with a maximum weight of about two pounds, were very plentiful in the stream. Many howler monkeys were seen and heard along the upper reaches of the river, but no crocodiles or iguanas were seen anywhere on this stream. At the point where the photograph was taken the stream bed is at least one hundred yards wide. From this fact some idea of the height of the jungle on either bank may be gained

The Senses of Fishes

By C. JUDSON HERRICK

Professor of Neurology, University of Chicago

OUR human world is a very limited part of nature. The unaided senses of primitive man open a few doors of communication between the individual and his surroundings, through which the sum total of his knowledge of things as they are must be derived. Science has greatly enlarged the efficiency of the natural sense organs—the microscope and the telescope have extended the range of vision, the periscope enables us to see around a corner, the spectroscope, photographic plate, X-ray machine, and innumerable other aids have enabled us to see deeper into nature. But no new senses have been developed and our furthest scientific advances and most recondite philosophical theories must be based in last analysis on such fragmentary knowledge of the cosmos as is revealed to us by our senses. Great realms of nature remain wholly unexplored, although new artificial aids permit constant advances into the hitherto unknown—Hertzian waves and wireless telegraphy, ions and the new chemistry, electrons and the new physics.

Fortunately the traditional five senses do not represent our whole physiological equipment for this task. In fact, the human animal is endowed with about twenty distinct senses, including two in the ear, at least four in the skin, and numerous others in the deep tissues such as muscle sense, hunger, thirst, and other visceral senses.

It is well known that fishes and other lower vertebrates possess numerous types of sense organs quite unlike anything in our own bodies, and it is quite impossible for us to form any conception of what the world appears like to these animals except in so far as their sensory equipment is similar to our own. Even the companionable dog, who responds so sympathetically and intelligently to our moods, lives in a very different world. Recent experiments have shown that his sense of vision is very imperfect, especially for details of form, and everybody knows the inconceivable delicacy of the hound's sense of smell. With us vision is the dominant sense and our mental imagery is largely in terms of things seen. Even a blind man will say, "I see how it is," when he comprehends a demonstration.

What sort of a world is it to a dog, whose finest experiences and chief interests are in terms of odors? And how does it feel to be a catfish, provided not only with large olfactory organs whose central nervous centers make up almost all of the cerebral hemispheres of the brain but also with innumerable taste buds all over the mucous lining of the mouth and gills and freely distributed over the entire outer skin from the barblets ("feelers") around the mouth to the tail fin? We cannot conceive the epicurean delights which such an animal may feel when he swims into the water surrounding a juicy piece of fresh meat, by whose odorous and savory juices he is bathed. One wonders, parenthetically, how far the fish himself is able to conceive or even enjoy the pleasures of life. With how much mind of any sort the fish is endowed is at present an unsolved riddle; but it is certain that his behavior complex is of very different pattern from ours and whatever mind he may have would surely be as different as the pattern of his sense experience is different.

Let us pursue this line of inquiry further and review what is known of the other senses of our catfish. This fish has small and poorly developed eyes and is largely nocturnal in habit, lying concealed in dark corners during the day. The retina has remarkable powers of adaptation to differences in illumination and the fish is very sensitive to changes in intensity of light. But the

eye is not the only light-sensitive organ. Experiments with blinded fish show that the entire skin surface is sensitive to differences of light intensity, a not uncommon feature of aquatic animals. The image-forming power of the eye is probably not very good. Some catfishes, it is true, will take a spoon hook, and probably a bait must always be in motion if it is to be sensed by the eye. The usual method of feeding is to trail the bottom with the barblets, which are very efficient organs of both touch and taste, and when contact is made with a worm or other suitable food to turn sharply and snap it up.

Just as the eyes are supplemented in their functions by the skin, which has a very feeble sensitiveness to light, so the highly refined chemical sense organs in the nose and taste buds are also supplemented by a chemical sense in the general skin. In some other fishes which have been carefully tested the general skin surface is found to be very sensitive to chemicals in solution, to some substances more sensitive, in fact, than are the taste buds themselves.

In fishes, as in men, the ear contains two quite different sense organs—the organ of hearing and the organ of the sense of equilibrium. The latter lies in the semicircular canals, which in form and function are similar to those in the human body. Indeed, the semicircular canals probably play a larger part in the behavior of the fish, since maintaining perfect equilibrium is a more difficult matter for a fish suspended in water of about the same specific gravity as the body than for a man walking on solid ground. But when the man essays to fly, his semicircular canals again take a dominant place in his sensory equipment. In the practical testing of the fitness of men who are candidates for the Air Service of the Army the most important point to be determined is whether the semicircular canals are functioning normally.

Whether fishes hear at all has been hotly controverted. That they are very sensitive to mechanical jars and vibrations all agree, but it has been difficult to prove whether their responses to these vibrations are brought about through their ears or by refined cutaneous sensibility. The ingenious experiments of Parker[1] have shown that both of these organs serve and that, in fact, fishes do hear true sound waves of rather low pitch with their ears. To tones of high pitch they are deaf and probably they have no power of tone analysis, that is, they can hear a noise but cannot tell one tone from another.

The fishes can boast no superiority over ourselves in being able to respond to low tones by both the ear and the skin. We can do the same, as can readily be shown by lightly touching the sounding board of a piano or organ when a low tone is struck. The same tone heard by the ear can be readily felt by the finger tips. But for perceiving still slower vibratory movements we, with all our boasted brain power, must admit ourselves inferior to the fishes. They possess an elaborate system of cutaneous and subcutaneous sense organs of which we have not a vestige. These so-called lateral line organs in the catfish comprise a complex system of fine tubes under the skin, the lateral line canals, and two kinds of sense organs in the skin, the pit organs. The canals ramify in various directions in the head and the main lateral canal extends along the side of the body back to the tail. They were formerly supposed to be for the secretion of mucus and are still often called the mucous canals. But they are now known to contain numerous small sense organs which respond to slow vibratory movements of the water. The pit organs are scattered over the skin, the smaller ones each in a flask-shaped pit with a narrow mouth and the less numerous larger ones exposed on the surface.

[1] See recent work on this subject by Prof. G. H. Parker, of Harvard University.

The lateral line sense organs are all supplied by a single system of nerves related to the nerves of the ear and quite distinct from those for the general tactile and chemical senses of the skin and the cutaneous taste buds. That the lateral line organs respond to slow vibratory movements has been clearly shown by Parker, but the distinctive features of the pit organs are unknown and, in fact, our knowledge of the functions of the system as a whole is still very incomplete.

It is clear that cutaneous organs of touch, lateral line organs, and the organs of equilibrium and hearing in the internal ear form a graded series, and all have probably been derived in evolution from a primitive type of tactile organ. When therefore we both hear and feel a musical tone of the piano we are reminded of the long and dramatic evolutionary history of the very intricate human auditory organ, whose first and last stages both may function at the same time in our own bodies.

We cannot here recount the details of the long series of very tedious scientific investigations required to replace the conjectures of amateur naturalists and fisher folk by accurate knowledge of the sensory life of fishes. And even with this precise information we are far from a true understanding of the fishes' minds. To learn the structure and behavior of any animal requires only sufficient scientific skill and industry, but to understand the mind of an animal is the most baffling of all scientific questions.

Our own thoughts are purely personal matters. Even with the aid of language, facial expression, and gesture, we are able to communicate our ideas and feelings to our intimate friends only imperfectly, and this difficulty is multiplied many fold when we try to understand even the most intelligent of the brutes. The only recourse is to see how an animal behaves in a given situation and then in the light of what we know of human and animal bodily structure and function try to imagine how we would think in such a situation, taking into account the animal's limitations of nervous organization. Obviously this is a poor and uncertain method at best, and no wonder many psychologists have given up the problem in despair and decided that the only scientific procedure is to pay no attention to animals' minds and limit our inquiry to their objective behavior. Indeed, so impressed are some of them by the futility of scientific study of even the human mind by introspection that they advocate throwing overboard the whole science of psychology. But this is too much like sinking the ship, cargo and all, to get rid of the rats.

No, if we wish to attain the heights of a true understanding of the significance of mind in evolution, we must keep to the steep trail and not yield to the temptation to take smoother paths leading to the rest shelters by the way. But we must watch our steps. By this I mean that, although we can interpret the animal mind only in terms of our own experience, yet we must not uncritically read our thoughts and feelings back into animals' minds. The only safe rule is to assume that an animal acts reflexly or unconsciously except when it can be shown that the unconscious mechanisms are inadequate to account for the behavior and intelligence alone is adequate. And these are very difficult things to prove in regard to animals so far removed from us in behavior type as are the fishes.

The popular dramatization of animal life and imputation to them of human thoughts and feelings may have a certain justification for literary or pedagogic purposes, the same as other fairy stories. But let it not be forgotten that this is fiction for children, not science nor the foundation for science; and there is a long, long road to travel before we shall be able to understand in any but the most shadowy outlines what a fish's mind is really like.

Recollections of English Naturalists

Few things in life bind together all sorts and conditions of people, irrespective of age, money, or any class affiliation; but natural history is a bond of such charm that it brings all to a common fellowship

By T. D. A. COCKERELL

Professor of Zoölogy, University of Colorado

ENGLAND is a land of amateur naturalists. The organization of British science for public ends, now going forward with extraordinary vigor as a result of the war, has in the past been sadly inadequate to meet the needs of the country. It is true that such institutions as Kew Gardens and the British Museum have rendered incalculable services to the British dominions and the world in general; but even these have not always received adequate support, and the government has never in the past shown any real disposition to foster research.

Yet there can be no doubt that the English, as a people, possess in a high degree those aptitudes which lead to success in science; and when conditions become more favorable who can say what may not be accomplished? The main obstacle, undoubtedly, has been the inadequacy of British education. Not only were the people in general brought up without scientific instruction; but the leaders, who mostly had every advantage which wealth and position could confer, did not, as the phrase is, suspect anything about science. Most of them able and sincere men, they will seem to posterity like valiant soldiers going to battle, having forgotten their weapons.

In spite of all this, brilliant scientific work was done, and the century of Darwin and Huxley, Bentham and the Hookers, Wallace and Bates, and a host of others, will always shine brightly in the annals of biology. One has only to consult a monograph on any branch of zoölogy or botany to see how great and varied have been the British contributions. Not only this, but the country has been and is full of lesser men, spending their leisure moments in the study of plants, insects, birds, or fossils; forming societies and organizing excursions; everywhere worshiping at the shrine of nature, and gathering data for the advancement of knowledge.

As I look back upon the activities of thirty years ago, I marvel at the pure zeal exhibited, the love of nature which could not be suppressed,—and then at the lack of organization for the application of all this energy to public ends. There was, no doubt, even a certain advantage in the disinterested and socially detached position of most scientific men. They were not in science "for revenue only," as is too commonly the case in America. They were not obliged to tilt at windmills, or break their heads against the walls of stupidity and ignorance. No, they were free to pursue their studies as they would, tracing the pattern of life without bias and without hindrance. Darwin, the greatest of their kind, regretted that he had not been able to do more direct service to humanity; but who today, for humanity's sake, can wish him to have done otherwise than as he did? May not the same be said, at least in some measure, of the great host of nonprofessional naturalists who followed in Darwin's footsteps?

Yet, after all, we must have organization; and England came very near to fearful and irremediable disaster because she could not quickly use even the science she had. Although in the last

century the English schools were so deficient in scientific courses, the youthful naturalist had access to some excellent sources of information. There were elementary "natural histories," suited even for children, with good colored illustrations. For those a little older, shilling books furnished guides to the butterflies, beetles, common objects of the countryside, common objects of the seashore. The book on butterflies contained a complete account and good figures of every species found in the islands. Then there were the museums. Not only the great British Museum, but many of the towns, such as Dover and Bristol, had museums, with good collections of the local fossils, insects, and other objects. Thus the boy was largely independent of formal instruction, and could puzzle out things for himself.

At the next stage, approaching manhood, the amateur scientific journals assumed great importance. The best of these, now unfortunately extinct, was *Science Gossip.* In its prime this magazine had great influence, of a kind which I think no periodical has today. It was really an organ of the amateur naturalist, in which he recorded his discoveries and advertised his duplicates for exchange. It was the means of bringing together innumerable devotees of the same subjects, who might be in different parts of the country or belong to quite different social groups. Free from commercialism and free from preaching, it really represented the democracy of naturalists, the rank and file. Another much less ambitious paper, *The Naturalist's World,* was published in Yorkshire. It was the organ of a society which carried on its affairs through the mails. It had something of the flavor of Gilbert White, and illustrated very well the saying of William Morris, that the secret of happiness is in the appreciation of the small affairs of life. To the modern rather supercilious doctor of philosophy, these productions would doubtless seem almost contemptible; but I can say, with many many others, that they gave us extraordinary pleasure at the time, and stimulated an interest which will never cease.

In a country like England, where the sorts and conditions of men are so diverse, few things bring all together on a common level. Natural history did this, and herein was one of its greatest charms. My brother and I, ardent conchologists, corresponded and exchanged with people in many parts of England, Scotland, and Ireland. Sometimes our correspondents would come to London, and we would invite them to tea at our house at Bedford Park. On such occasions the whole family would be agog with curiosity to see the stranger. He might be a country minister, an officer in the army, an aristocrat, a man in a small way of business, —almost anything, in fact. In any event, he was a personality, and the bond of interest always made the meeting pleasurable.

The love of snails could bridge all differences of years or social status. It would be hard to exaggerate the uniform kindness shown by older men to us youngsters; the long letters they wrote, the trouble they took in identifying specimens, their generosity with their duplicates. The one we held most in respect was J. Gwyn Jeffreys, the author of *British Conchology,* our standard work of reference. He lived in London, but we never saw him; a post card came from him on the very day he died, the last of a long series of letters and cards; sometimes, when there was much to discuss, coming almost daily. He was greatly disappointed that the British Museum would not purchase his collection. It was eventually sold to the United States National Museum, and Dr. Jeffreys wrote me a long letter about it, contrasting the attitude of the two countries. I fear his extremely flattering opinion of the con-

chological activity in America was hardly justified by the facts.

It was in an effort to see J. Gwyn Jeffreys that on May 20, 1884, I went to a meeting of the Zoological Society of London. It is a custom of the scientific societies in London to allow visitors to attend the meetings, if a fellow will sign his name after theirs in the attendance book. I think it was J. Bland-Sutton, now an eminent surgeon, then known for his studies in comparative anatomy, who signed for me on that occasion, as he certainly did many times thereafter. Jeffreys was to read a paper on the Mollusca of the "Lightning" and "Porcupine" expeditions, but to my great disappointment he was not able to be present. The president, Professor W. H. Flower, was in the chair, and Dr. P. L. Sclater, the secretary, read the minutes. F. E. Beddard read a paper on the Isopoda of the "Challenger" expedition; Francis Day, well known for his work on the fishes of India, spoke on hybrid Salmonidæ; F. Jeffrey Bell, of the British Museum, gave an account of the Cuvierian organs of the "cotton-spinner," a holothurian. Then Dr. Bowdler Sharpe exhibited a new nuthatch from Corsica, and I think it was Henry Seebohm who showed skulls of Asiatic wild sheep. Altogether a wonderful occasion for a young man of eighteen, just old enough to realize that he was listening to the voices of the gods! After that, thanks to the unfailing kindness of the society, although I was much too poor to think of becoming a fellow, I was allowed to attend the meetings and use the library as much as I pleased.

The library helped me a great deal, as it was close to my residence, and as it was compact and entirely zoölogical, it was very easy to make cross references and find whatever I wanted. Mr. F. H. Waterhouse, the librarian, was one of the kindest of men. He so closely resembled his brother, the distinguished entomologist at the British Museum, that for a time I did not realize that they were not the same person. At the meetings, Flower nearly always presided, though I recall an occasion when St. George Mivart was in the chair. Sir William Flower was head of the natural history department of the British Museum (really a separate museum), and whether seen in that capacity, or as president of the Zoological Society, he was remarkable for a gentle courtesy which seemed to make everything go smoothly. Temperamentally, he was an entirely different man from Sir E. Ray Lankester, who succeeded him at the Museum.

About the time I first attended the Zoological Society, I began to go regularly to the British Museum. When I was a very small boy, my father took me to the Museum, and two things he said, as I marveled at the objects displayed, have always remained in my mind. He said, "My son, this is *your* Museum," and then explained how it belonged to everybody in the country, and all should support it and take pride in it. Then he said, "Perhaps some day, when you grow up, you will find something worthy to be placed in this Museum." I thought that if that ever happened, I should be the happiest person alive. To this day, the place appeals to me with an indescribable romance, and my wife says that when I die, if I get my wish, I shall go to the British Museum instead of to heaven.

At the natural history branch of the British Museum, at South Kensington, the entomological collections are mainly kept in the basement. It is also in the basement that researches on Mollusca are carried on, the specimens required being brought in a large wooden tray by an attendant. The student goes down a flight of steps, and rings an electric bell, whereupon the door opens. He signs his name in a book, and is then allowed to go to the room where he expects to work. If he goes regu-

larly, he has to have a student's card. These precautions are obviously necessary; but once they have been taken, everything is done to facilitate one's work.

I undertook at one time to investigate the slugs (naked land Mollusca) in the Museum, and it seemed a marvelous thing to have before me the historic specimens of famous authors, even including some collected in the eighteenth century by Sir Hans Sloane, the founder of the Museum. When a paper was written, it was necessary to submit it to Dr. Albert Günther, the keeper of zoölogy in the Museum. Günther had none of Flower's urbanity, and we were all rather afraid of him. It was currently believed that the best time to see him was just after lunch. I confess I thought him rather unsympathetic, to say the least; but I now recognize that he had a lot of good sense, and I have only kindly thoughts of him. The last time I saw him was shortly before his death, in the department of fishes. I had grown much older and altered in appearance, and as he did not recognize me, I did not speak. I have regretted that I did not find some way to express my feelings toward him; but doubtless he did not consider that his contact with me had been anything more than that of museum routine, and would have been surprised that I had given it much thought.

Occasionally I went to the meetings of the Entomological and Linnean societies. At the Entomological, the one great event I recall was seeing the venerable J. O. Westwood take the chair, and make a communication on a new plant louse found on the breadfruit tree in Ceylon. Westwood was by all odds the greatest of entomologists, and W. F. Kirby well said of him, in my hearing, "He never gets tired." Physically, of course he did; but his zeal, like that of the botanist Sir Joseph Hooker, never faded until death came in extreme old age. Henry T. Stainton, well known for his book on British Lepidoptera, I also saw at the Entomological. When Stainton died, Westwood read the obituary in the *Entomologist's Monthly Magazine,* and remarked, "The next number will record the death of another old entomologist." So it was, for Westwood had come to the end of his days.

At the Linnean I have the liveliest recollection of hearing Patrick Geddes on anabolism and katabolism, and all the theory he wove out of and around these conceptions. The presentation was brilliant and interesting, and preoccupied the mind for a long time, as does a well-acted play.

A society which I regularly attended was the South London Entomological and Natural History Society, meeting in rooms near the south end of London Bridge. It included collectors and amateurs and, in particular, students of the British fauna. There was always a good series of exhibits, especially of remarkable varieties or rare species. Here one would meet J. Jenner Weir, of Beckenham, well known as a friend of Darwin and close student of the Lepidoptera in their more philosophical aspects. Here also came J. W. Tutt, a schoolmaster by profession, with unbounded enthusiasm and decidedly radical views about entomology. It was Tutt who produced an elaborate study of the variations of the British Noctuidæ, naming all the forms, and who later undertook a vast work on British Lepidoptera in general, which he did not live to finish. He also published a charming series of books on his natural history rambles, and a guide to the British butterflies, and founded that lively journal *The Entomologist's Record and Journal of Variation.* A nervous and sometimes quarrelsome man, he made many enemies; but in the course of time he gained general respect, and the affection of many. He had just been elected to the presidency

of the Entomological Society when he died.

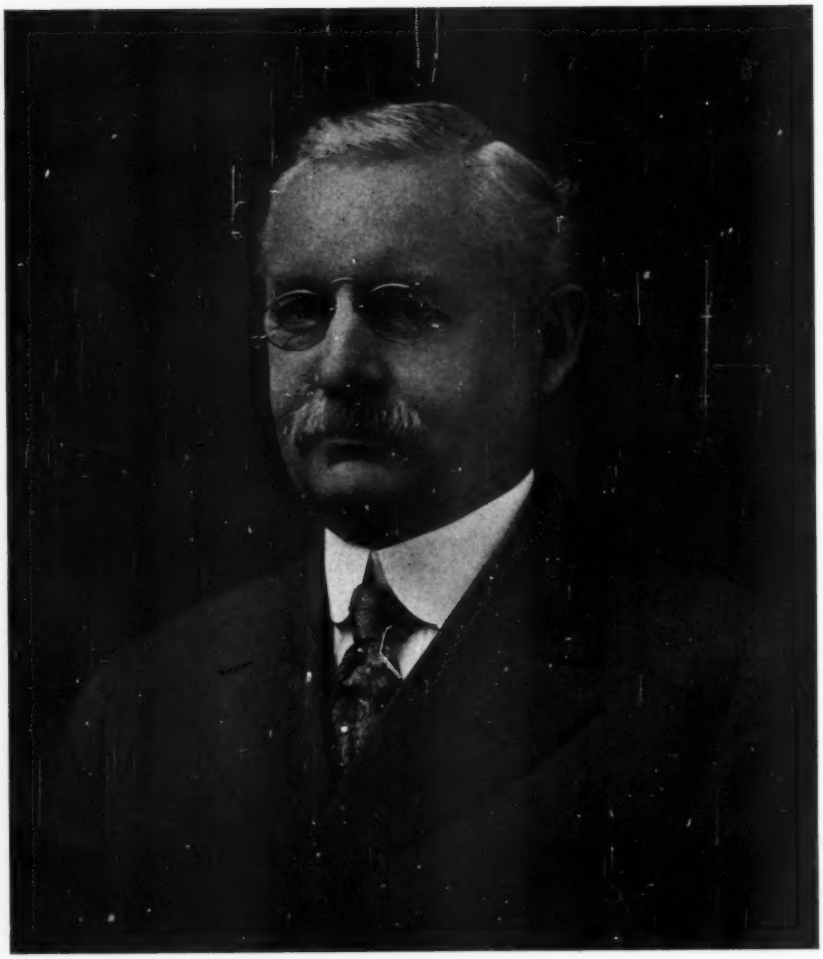
Going back to a much earlier date, I count among the most potent sources of my interest in natural history the work of John W. Taylor and W. Denison Roebuck, of Leeds. A notice appeared stating that a *Monograph of the Land and Freshwater Mollusca of the British Isles* was to be published in parts. It was to be fully illustrated, and as exhaustive as possible. It would include not only all British species, but all foreign varieties of British species, with full details about distribution, habits, etc., etc. The author, Mr. Taylor, was to be assisted by Mr. Roebuck, who had specialized in the slugs. My brother and I quickly responded to the appeal to send specimens, as material was desired from every locality, and nothing came amiss. Our joy was great when we found that we had discovered an entirely new variety (*Helix hortensis* variety *lilacina* Taylor) and another new to Britain. Almost every trip produced something interesting in the way of slugs, for England has a splendid slug fauna. Many preliminary papers appeared, but it was a long time before the first part of the monograph was ready. It is still incomplete and, owing to the war, publication had to be suspended; but we may hope that it will be continued, and that Mr. Taylor will be able to bring it to completion. I never saw either Taylor or Roebuck, but there are few persons to whom I feel more indebted.

In recording the above details I have been interested to describe some of the influences which, in my experience, tended to develop and mature an incipient interest in natural science. Taken altogether, these influences constituted a potent environment, without which even a strong inborn tendency might have come to nothing. In a measure, they represent the peculiar genius of the English nation, which cannot be exactly duplicated elsewhere; but in our own way and through the means we have, we should in America strive continually to create conditions more favorable for the stimulation of scientific interests. We have indeed some great museums, learned and influential societies, and excellent publications; but the country is vast, and we are only beginning to develop its intellectual possibilities.

More particularly, I think we should in America regard the amateur, and give him a chance to coöperate in large undertakings. In this period of reconstruction, science must be our guiding star; but in the struggle for wealth and power, science is in peril. Under existing conditions science tends to become commercialized, and economic necessity forces young men into positions where financial gains dominate all other considerations. The State must bid against all this, not by offering larger salaries, but by elevating and dignifying public service and the scientific life.

But even so, it can perhaps count among the faithful only those who have early learned to love research, and to whom science is not merely a means, but an end,—the advancement and elevation of human thought. Thus, whether in leisure moments snatched from a busy life, or in the service of the public, naturalists may remain amateurs in the old-time sense of the word, lovers of a mistress whom they could not betray.

Such a spirit may resist even the temptations of business life, and we may see commerce suffused with new motives, as the distinction between public and private purposes becomes obliterated. So much depends upon the mode of approach; and Great Britain, the land of amateurs, will, I think, in this hour of need find in her service a group of men and women whose sincerity and devotion are beyond reproach.



EDWARD W. NELSON

Chief, United States Biological Survey

As a noted American naturalist, for forty years the friend and student of wild bird and mammal life, Mr. Nelson has accompanied or led many expeditions to the western deserts, to Mexico and Central America, and to the Arctic. He served in several capacities on the staff of the United States Biological Survey and in 1916 was appointed chief. Mr. Nelson's contributions to the technical literature on the North American birds and mammals is very extensive; recently he has enlarged his audience by the publication of a popular book, *Wild Animals of North America*. The value to the layman of this account of our native mammals is increased by an unusually profuse illustration, natural color portraits from paintings by Louis Agassiz Fuertes, track sketches by Ernest Thompson Seton, and many photographs. The book was given preliminary publication in the *National Geographic Magazine* of November, 1916, and May, 1918

Nelson's "Wild Animals of North America": A Review

By JOEL ASAPH ALLEN

Curator of Birds and Mammals, American Museum; Editor of the American Museum's scientific zoölogical publications (1889 to 1918); Honorary Member of the New York Zoölogical Society; Foreign Member of the Zoological Society of London

ONE of the most valuable of the many important contributions of the National Geographic Society to popular education is Edward W. Nelson's account of the mammals of North America,[1] with colored illustrations by Louis Agassiz Fuertes, track illustrations by Ernest Thompson Seton, and half-tone reproductions of photographs of especial interest and pertinence, published, as stated by the editor of the magazine, at a cost of $100,000. The account was originally issued in two parts, "The Larger North American Mammals," in November, 1916, and the "Smaller Mammals of North America," in May, 1918. The two parts are now issued together in book form, greatly facilitating their use as a convenient work of reference, useful alike to the naturalist and the general reader.

Excellent books on North American birds, many of them well illustrated, have long been available, and also a number of magazines exclusively devoted to these easily observed dwellers in our midst, graceful and attractive in form as well as vivacious and songful, their nest building and manner of life open to all observers. It is easy for anyone with the slightest interest in these wonderful creations to know intimately their life habits and to have a fair knowledge of perhaps a hundred species that frequent their home surroundings of field and woodland. On the other hand, it is safe to say that the wild mammals equally well known to them can be counted on the fingers of a single hand, and of only two or three of which will they have more than slight knowledge of their manner of life.

[1] *Wild Animals of North America:* Intimate Studies of Big and Little Creatures of the Mammal Kingdom. By Edward W. Nelson. Published by the National Geographic Society, Washington, D. C., 1918.

Mammals have, as a rule, no vocal powers to attract attention; they are, for the most part, secretive and nocturnal in habits. Of the hundreds of field mice and shrews and moles that inhabit the fields and meadows through which we daily walk only a rare accident may bring even one of them to our ken. Only the hunter and the trapper know the haunts of the fur bearers and the game animals. Only the professional field collector, with his resources of skill and of especially devised traps, has the opportunity and the required knowledge to unveil the mysteries of our smaller mammal life. There is no "color key" or other popular device to aid the amateur in finding out the names and relationships of the forms he may chance to obtain. The recognition of their distinctive features requires more or less technical training on the part of the observer before he can determine the specimen he may chance to have acquired.

The requisites of an author who could successfully prepare a volume like the present one are numerous and varied. Fortunately, Mr. Nelson, chief of the United States Biological Survey, is the possessor of them all in a high degree. Inspired with a love of the wild and, above all, with the spirit of research and discovery, his natural history explorations have taken him throughout the continent from the Arctic tundras of Alaska to the jungles of tropical Mexico, and have made him familiar alike with the life of the desert and the forest. While an ardent ornithologist, he is equally an ardent mammalogist and a broadly trained naturalist able to impart his experiences and observations with sympathy and directness. He has lived with the animals

of which he writes and has studied them in their homes; on the technical side he is a monographer of many of the groups of which he so tersely and clearly sets forth the life histories.

The forms (species and local races) of mammals now recorded from continental North America number nearly 2500, yet they are reducible, so far as their distinctive traits are concerned, to a few hundred types. As North America, in the sense of the present work, is mainly the continent north of the tropics, Nelson's biographies of about 120 groups comprise all of the types of this large area which are of primary interest, from the large game and fur-bearing animals to the bats, shrews, mice, and squirrels. Thus, the hares and rabbits, numbering approximately one hundred local forms that are considered worth distinguishing under the "higher criticism" of modern days, are treated as constituting six groups, each illustrated in color, and the distinctive external characteristics and habits of the constituents of each are clearly and satisfactorily presented. Never before has the general reader had placed before him in a connected and well balanced summary so much essential information about North American hares and rabbits. And the same is true of all the other biographies.

Mr. Nelson, in his introductory pages, contrasts the early days of the settlement of North America with present conditions in respect to the larger mammalian life of the continent—the abundance in the seventeenth and eighteenth century times and the pitiful remnants that now remain—and makes a strong appeal for the conservation of wild life. In the introduction to the second part, the "Smaller Mammals of North America," a dozen pages are given to the generalities of the subject, which are condensed under such suggestive subheadings as "Animals that learned to 'dig in,'" "A departure for every need," "Strange adaptations to meet conditions of environment and competition," "Geography and color," "Gnawers most numerous of mammals," "Good housekeeping in rodent land," "The ebb and flow of antagonistic species," "Countless beasts that roam the night," "Animals that put themselves in cold storage," "Defensive and offensive animal alliances," etc. Under these captions are presented a wide range of general statements and philosophic deductions, as the evident close relationship of certain northern forms to Old World types, and the presence on our southern border of a similar affiliation with tropical American types, while others still are distinctly of North American origin with no close relationship to groups found elsewhere.

The special adaptations of species to their particular environments, and to very diverse conditions of life, as arboreal, subterranean, aquatic and aërial, and the modifying effect of climatic conditions, resulting in the development of geographic races in species which have a wide range, are also among the topics presented. The ability of desert inhabiting species to live without drinking, "through chemical action of their digestive tracts, whereby some of the starchy parts of their food are changed into water," is also noted; also the storing of food for winter use by some species, while others pass the winter in a torpid condition and thus do not require food. Molting, or the seasonal change of the coat, is also the subject of comment, and likewise the concurrent change of color from brown to white in autumn and the reverse in spring in many northern animals as a protective provision against enemies. In this connection a misapprehension of former days in respect to how the change in color is brought about is, let us hope, finally given its quietus by this statement of the now known facts of the case: "It was formerly considered that the change of mammals from the brown of summer to the white winter

coat in the fall, and from the white to the brown in spring, was due to a change in the color of the hairs, but it is now known that it is entirely due to molt. The time of these changes depends on the season, and this varies several weeks, according to whether the fall or spring is late."

Mr. Seton's illustrations and descriptions of the footprints of a large number of different kinds of mammals, when walking and when running, add a novel and interesting feature from a field that he has made practically his own. The subjects range from bears, coyotes, and other carnivores to deer, moose, and caribou among the larger mammals, and from jack rabbits and squirrels to field mice and shrews. They will vividly recall to many readers the imprints seen by them in newly fallen snow during many a winter walk in the country. In these sketches, entitled "Footprints of Nature's Wild Folk," Mr. Seton tells us he "usually gives the track of a normal adult animal in about one inch of snow, that being ideal for tracking. Some of the smaller kinds are shown in fine dust. The trail goes up or across the page at the ordinary gait of the animal. . . . While there are endless variants in each kind, I aim to give the reader at least one typical set of each." There are nearly sixty of these sketches, which represent the leading types of mammals over a wide range of country.

Mr. Fuertes' colored illustrations are of course of the highest excellence, and give the reader a vivid conception of the varied forms of mammal life in North America. Our foremost bird draftsman may now be awarded equal honor in another field.

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The American bison once roamed the central plains and forests of North America as sole monarch, supplying the basis for some of our most picturesque Indian cultures. Even as late as 1870 it was estimated that five and a half million head still survived west of the Mississippi, but today there are not more than 4000 and these are gathered in Canadian and American preserves. Under primitive conditions the buffalo herds migrated northward and southward with the seasons, always following the same trails which were consequently worn into permanent landmarks. Indeed some of our highways and railways follow in the footsteps of these wild travelers

Courtesy of the MacMillan Company

Watching for the first sign of a forest fire.—To protect the vast resources of our National Forests an extensive patrol is maintained. Mr. Boerker tells of the vigilant work of this army of rangers who during 1916 extinguished 5655 forest fires, saving hundreds of thousands of dollars' worth of timber and perhaps many lives. Lookout men are posted in small cabins on prominent mountain peaks or on high hills where they can observe wide areas and watch for fires day and night during the danger season. Telephone lines connect the posts with central stations so that information can travel quickly and the fire fighters be rapidly mobilized

"Our National Forests"[1]: A Review

By BARRINGTON MOORE

Research Associate in Forestry, American Museum; formerly in the United States Forest Service; Major of Engineers, American Expeditionary Force

"Our National Forests" is a book by Mr. R. H. D. Boerker, Arboriculturist, Department of Parks, New York City, a man who was with the United States Forest Service from 1910 to 1917. The book should be considered from two distinct points of view: (1) that of the professional forester familiar with the National Forests and their administration by the United States Forest Service; and (2) that of the general public. The first point of view requires an accurate statement of facts, the second requires that the facts be interestingly presented. It is difficult for any one reviewer to take both points of view at once. If he is a professional forester he will judge the book on the accuracy of its facts, and he cannot avoid having interests which may not have a lively appeal to the general reader. If, on the other hand, he is not a forester, he will know whether or not the book is interesting, but not if it is accurate. The reviewer in this case, having been in the United States Forest Service for five years—on the National Forests, in the District Office and lastly in the central office at Washington—must confess to belonging in the first category, and will judge the book by its accuracy—although it seems to him to be also very interesting in the manner of presentation of its facts.—B. MOORE.

THIS new book on our National Forests does not attempt a general description of the National Forests in themselves. Such descriptions we already have from the pens of John Muir, Theodore Roosevelt, and other lovers of our great West. Mr. Boerker gives us rather the human side of these forests as revealed in the work which the United States Forest Service is doing to administer them. He has given us the first

[1] Boerker, R. H. D., *Our National Forests*—A short popular account of the work of the United States Forest Service on the National Forests, pp. i–l; 238; 80 illustrations. The Macmillan Company, N. Y. 1918.

complete and faithful account we have of the activities of the Forest Service and of the relation of the National Forests to the welfare of the people. He sketches briefly the history of the establishment of the National Forests and the development of the Forest Service. He covers in detail the administration of the National Forests and the scientific work of the Service. His account of how forest fires are detected and fought is most interesting. We are told how the timber is sold and cut in such a way as to preserve the future of the forest; the value of the National Forests to the livestock industry, and how the forage is made available to this industry; lastly we are told of the other uses of the National Forests, such as water power and summer camp sites. This is but an outline of the main subjects treated; it would be impossible to summarize in small space all the interesting information contained in the book.

Mr. Boerker, I would say, is not quite fair to the lumbermen (Introduction, page xlii) when he says, "Lumbering has been and is today forest destruction." In the Northeast, particularly in Maine, lumbermen are awake to the evils of forest destruction and anxious to practice forestry. In fact they are practicing forestry, somewhat crudely perhaps, but as well as the present economic conditions permit. Such a statement as this tends to perpetuate unnecessarily the old animosity between lumbermen and foresters, which has died down as each has come to realize his dependence on the other.

In advocating Government control of cutting on private lands (page l), Mr. Boerker goes somewhat farther than even many ardent advocates of forest conservation. In France, where forestry is well established, the owner can cut without consent of the Government and as he pleases, provided he does not reduce the area under forest.

In the historical part of the book (page 14), the author gives credit to President Harrison for creating the first Forest Reserve. This may be correct, but we have always understood that President Cleveland initiated the policy of setting aside public land for Forest Reserves, and that President Roosevelt developed this wise policy to its present point.

The author gives the Forest Service great credit for its remarkable work and high efficiency, but does not sufficiently emphasize two of its most important accomplishments. When the Forest Service took over the National Forests under Roosevelt's administration, much of the grazing land on them was in bad condition through previous overgrazing and abuse. To restore this land by closing against grazing inflicted a great hardship on the stockmen. Accordingly the Forest Service undertook a thoroughgoing scientific study of the problem, and discovered a way by which the range can be fully restored without closing against grazing and without the expense of artificial reseeding. The practice of sheep grazing was revolutionized, much to the benefit of the industry, and the carrying capacity of the National Forests was greatly increased.

The Forest Service has greatly benefited the lumber industry also. A lumberman operating on private lands must buy up enough standing timber to supply his mill for a number of years ahead; often he buys enough for twenty years. Obviously this means an enormous initial investment on which he has to pay interest, taxes, and the cost of fire protection. In operating National Forest timber no such outlay is required. The lumberman simply pays as he cuts, and saves the expense of interest, taxes, and fire protection.

The Forest Service is, as the author states, under Civil Service. It has always jealously guarded against political influence of any kind. We have here an example of the high accomplishment of which our Government is capable when politics are kept out.

Our National Forests should be widely read. It not only contains a rich fund of valuable information presented in a clear and interesting manner, but also represents the first opportunity the people of the United States have had of readily learning what the Government is doing with one of its greatest natural resources.

SPEND AT LEAST AS MUCH FOR VEGETABLES AND FRUIT AS FOR MEAT AND FISH SPEND AT LEAST AS MUCH FOR MILK AS FOR MEAT OR AS MUCH FOR MILK AND CHEESE AS FOR MEAT AND FISH THIS PROPORTION IN BUYING FOOD WILL LOWER THE COST OF ENERGY AND MAKE SURE THAT THE NEEDED AMOUNTS OF MINERAL SALTS AND VITAMINES ARE INCLUDED
THESE FOODS SUPPLY A WELL BALANCED AND ADEQUATE DIET FOR A FAMILY OF FIVE FOR A WEEK THE FOOD COSTS 32 A WEEK WHICH IS 42 PER CENT OF A YEARLY INCOME OF $1500 PREVAILING PRICES IN NEW YORK DECEMBER 1, 1918
CHEAPEST SOURCES OF CALORIES
CHEAPEST SOURCES OF PROTEIN
CHEAPEST SOURCES OF CALCIUM
CHEAPEST SOURCES OF PHOSPHORUS
CHEAPEST SOURCES OF IRON
COST OF FOOD VALUES AS BOUGHT IN DIFFERENT FOODS
FRESH COD 2 LBS. 30¢
STEW LAMB LBS. 30¢
PEANUT BUTTER
CHEESE 1 LB. 40¢
APPLES 3 DOZ. 25¢
6 EGGS 45¢
BANANAS 1 DOZ. 20¢
ORANGES 3-15¢
RAISINS 3 LB. 71¢
APRICOTS 1 LB. 20¢
PRUNES 1 LB. 17¢
DATES 1 LB. 25¢
BUTTERINE 3 LBS. 1.26
SUGAR 4 LBS. 40¢
SUGAR
CHUCK STEAK 2½ LBS. 63¢
SPINACH 15 LBS. 15¢
BREAD 12 LBS. 1.20
CANNED TOMATOES 2 LBS. 32¢
POTATOES 12 LBS. 54¢
ROLLED OATS 2 LBS. 18¢
FLOUR 2 LBS. 12¢
BEETS 2 LBS. 12 OZ. 10¢
CARROTS 2 LBS. 25¢
RICE 1 LB. 15¢
CORNMEAL 1 LB. 8¢
TAPIOCA 1 LB. 8¢
DRIED BEANS 1 LB. 10¢
DRIED PEAS 1 LB. 14¢
COCOA ½ LB. 15¢
MACARONI 1 LB. 10¢

FOR A FAMILY OF FIVE FOR ONE WEEK

The one hundred and twelve pounds of foods shown will supply a family of five with an adequate and well-balanced diet for a week. It is not feasible to remember the merits and deficiencies of each separate food, but foods naturally fall into about ten groups and the characteristics of these can be easily carried in mind. The three groups, milk, grain products, and vegetables, form the foundation of a diet, and the other groups, meat and fish, nut products, cheese, eggs, fruits, fats, and sugar, are used to give additional energy, protein, mineral salts, and vitamines. (Photographed from the Food Exhibit at the American Museum of Natural History)

Food for a Family of Five[1]

By MARY GREIG

Assistant in the Department of Public Health, American Museum

RECENTLY two investigators in nutrition undertook to find out whether laboratory rats could pick out an adequate diet for themselves if left to choose from a variety of food set before them "cafeteria" fashion. The rats selected a pretty good diet, although perhaps not quite as good a one as the nutrition experts could have chosen for them.

Studies of diets from all parts of the world have shown that human beings, too, tend to choose adequate diets when food stuffs are abundant and varied. But, as a matter of fact, most of us do not have great enough variety in our diet to give this tendency room to work in.

A woman stood looking at the food exhibit in the American Museum. She turned—"Huh, I know how to buy the right foods all right—I guess every mother does, but the prices is so high." The critic partly answered her own criticism. It is just because the prices are so high that instincts do not find opportunity to work themselves out. Science must come to the aid of instinct under the conditions of modern civilized life. Already in one country even the law questions whether parents feed their children correctly just because they are parents: in England in 1906 an act of Parliament was passed to the effect that although a man may think he provides his children with food sufficient for their needs, if a school committee think otherwise, he may be forced to pay for other meals provided by the committee and charged to him.

Probably the other chief reason that we do not choose perfect diets is our individual "likes" and "dislikes." An extreme case will show how this works. A workingman came from a grocery store, eating a bunch of celery. I went in and inquired the price of celery. It was fifteen cents a bunch. At present food prices the lowest sum that will buy adequate food for one grown person for a day is about forty-two cents. This man would need from 3000 to 4000 calories a day, the celery would furnish about 30 calories. The man had spent one third of his money and he had received only $\frac{1}{100}$ of his energy. (The mineral salts in celery can be bought more cheaply in other foods.) If we see a girl shivering in a thin coat and wearing silk stockings and fancy shoes we smile, but we live in a glass house if we buy a "nice thick steak" or a "few lamb chops" before we have told the milkman to leave at our house every morning a quart of milk for every child and a pint for each grown-up. L. B. Mendel, of Yale, has said, "No one should buy tomatoes and lettuce unless he can afford an automobile"—although, as they are both valuable foods, we might buy them occasionally—as we would call a taxi.

Does it "matter" whether we know food values or not? Evidence is accumulating every day that it does. Recent study of life insurance statistics shows that when people are overweight they decrease their "expectancy of life." "After the age of thirty-five, overweight is associated with increasingly high death-rate, and at middle life it becomes a real menace to health."

It is estimated that at least 10 per cent of our school children are undernourished. This condition is not confined to the children of the poor; in a study of more than 5000 children in Boston some of the undernourished children came from well-to-do homes.

A Phipps Institute study of the garment trade shows that "malnutrition is one of the most potent causes of tuberculosis among the working classes."

A recent study of ninety-two family diets in New York City might be summed up as follows: Food deficiencies were frequent where the amount of money spent for food was enough to supply sufficient nourishment had it been spent wisely. The money was spent in such a way as to give high amounts of protein at a sacrifice of energy—59 per cent of the families were getting less than the standard 3000 calories and only twelve families too little protein. One half the

[1] The department of public health of the American Museum has installed in the forestry hall of the Museum an exhibit showing, among other things in wax reproductions of actual foodstuffs, an ideally proportioned diet for a family of five, based on the food needs of the body. The exhibit shows a week's food supply bought for $12 at prices prevailing in New York about December 1, 1918. This selected diet furnishes energy at the rate of fifteen cents a thousand calories, which is about as cheap as energy can be bought now in a diet adequate in other essentials.

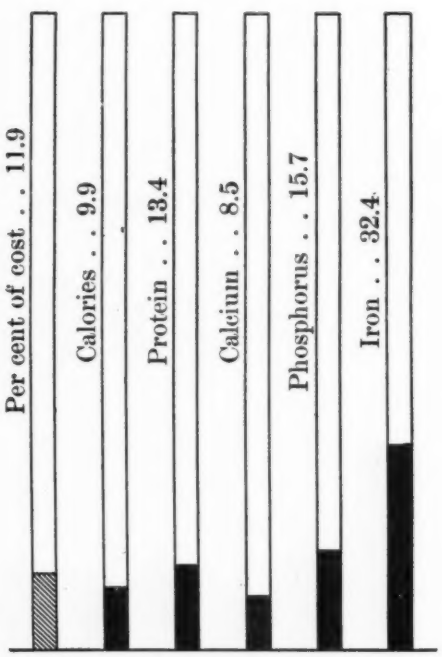
families were spending more than one third of the food money for meat and fish. It was also found that one group of families which spent forty-six cents was getting no more food value than a group that was spending twenty-five cents.

The amount of money spent annually for food in the United States is somewhere around $7,000,000,000.

Intensive investigations made in the last few years to learn how families actually spent their food money, have resulted in the discovery that the average American family spends too much of its food money for meat, poultry, and fish, spends in fact one third when it should spend only one tenth; that it spends not nearly enough for milk and cheese, too much for sugar, and too little for vegetables and fruit.

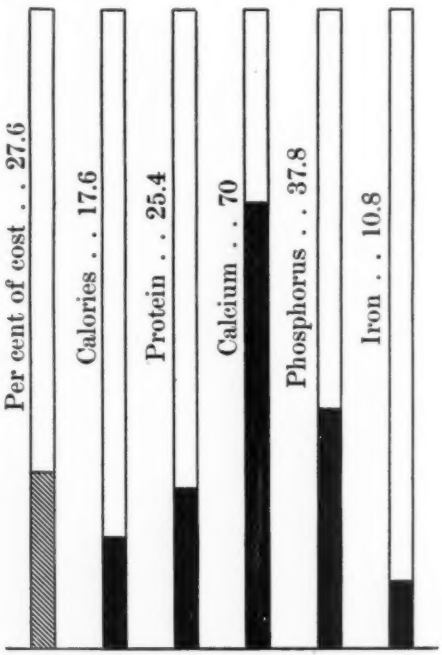
When the National War Labor Board was chosen to look into labor difficulties during the war it became necessary for them to know how much it costs to live. The estimates of the experts whom they called in ranged from $1100 to $1500 a year for a subsistence minimum in a large eastern city for a family of five. If $1500 is selected as the yearly income of such a family, then the amount it may legitimately spend for food will be from 40 to 50 per cent of this, which comes to about from $11 to $13 a week.

The body has need of many more things in its food than the six that we hear so much talk about, namely, calories, protein, calcium, iron, phosphorus and vitamines, but, if we make sure that these are supplied in correct amounts, all the other needed materials will be included.



Per cent of total food values obtained from vegetables

No one group of foods furnishes a complete diet because each is lacking in some essentials and abundant in others. The accompanying three diagrams represent the figures given for vegetables, milk, and grain products, respectively, in the "Percentage of the total diet" table. The total heights of the columns indicate 100 per cent, while the shaded part of the columns marks the actual percentage of the total supplied by the vegetables, milk, or grain products. For example, 11.9 per cent of the total cost of the sample diet was expended on vegetables from which was derived 32.4 per cent of the iron found in the diet



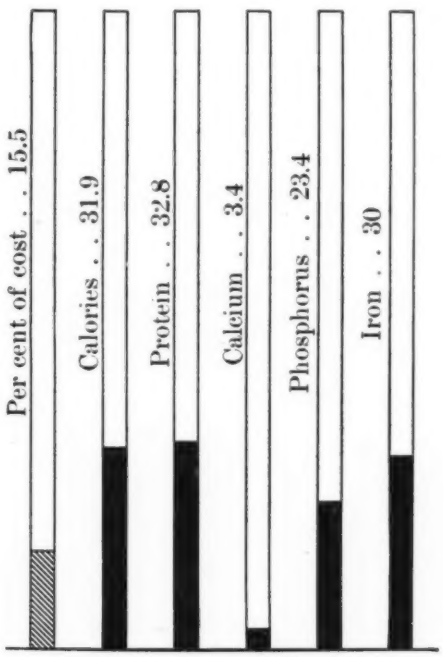
Per cent of total food values obtained from milk

Milk is the cheapest of our common sources of calcium and a fairly cheap source of protein. It is, however, much more expensive as a source of iron than are vegetables. On the whole we spend relatively too little for milk and cheese and too much for eggs and meat. A quart of milk a day for a child is considered as a fair standard for the calcium and protein found in milk make it particularly important in the diet of growing children. Milk is also one of the chief sources of the fat-soluble vitamines considered essential in a healthful diet

Percentage of the total diet

	Protein	Calories	Calcium	Phosphorus	Iron	Cost	Actual wgt. lbs.
Grain products	32.8	32.	3.4	23.4	30.3	15.5	19
Milk	25.4	17.6	70.	37.8	10.6	27.6	46
Vegetables	13.4	9.9	8.5	15.7	32.4	11.9	22
Meat	16.5	4.7	.9	9.8	11.3	12.	6
Eggs	1.8	.7	.7	1.3	2.4	3.7	.9
Cheese	4.8	2.4	11.8	6.	1.2	3.2	1
Fats	.6	15.	.6	.5	.6	10.3	3.5
Sugar	....	8.9	....	....	....	3.2	4
Nuts and nut products	2.4	1.6	.5	1.9	1.	1.3	.5
Fruits	2.1	7.	2.7	3.5	9.7	10.6	9

Tabulated above is a comparison of food groups in the diet selected for the American Museum exhibit, showing in terms of percentage, the food values and which foods yield the most for the money spent. This diet will supply all the food needs of a typical family of five, say a father engaged in moderate muscular work, a mother, a boy of twelve and one of six and a girl of ten. The diet covers the six requirements usually considered and therefore all the other essentials.



Per cent of total food values obtained from grain products

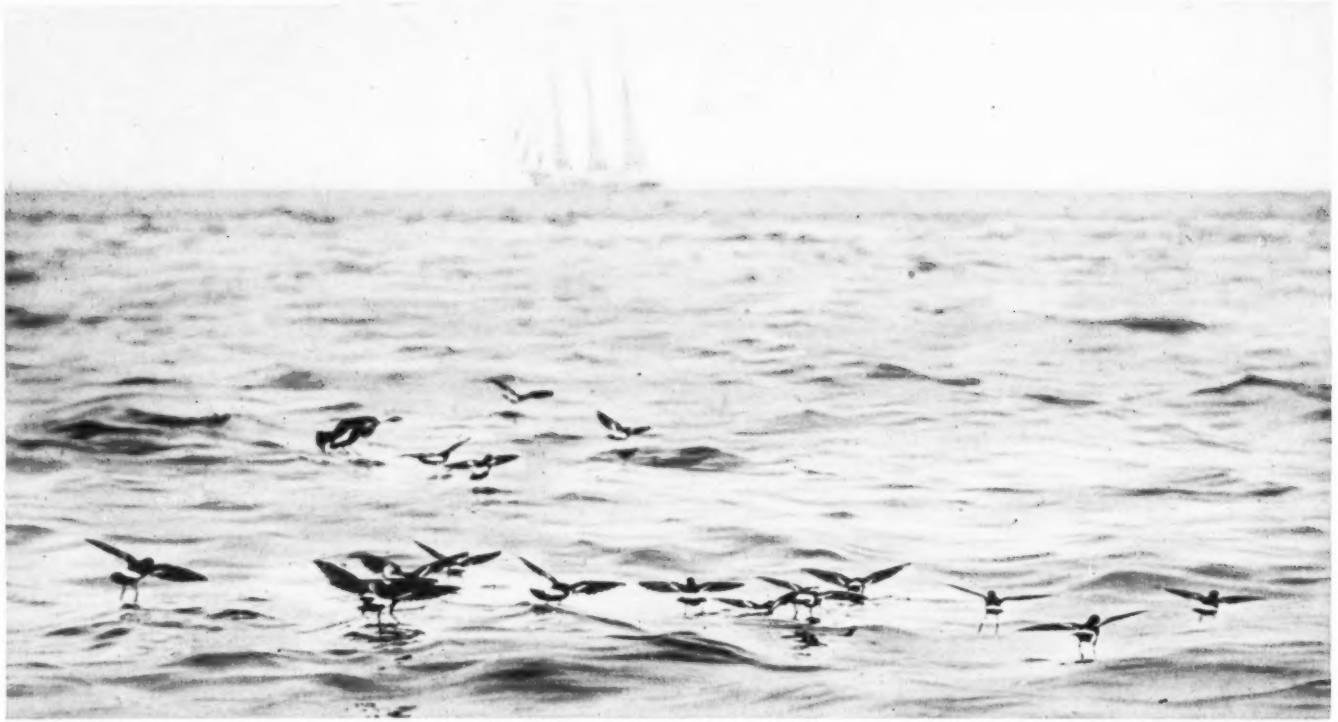
Grains are almost the cheapest source of energy among the various foods and as the need for cheapening the diet increases, greater reliance must be placed upon them for supplying the foundation of our nourishment. As the chart shows, however, grain products are conspicuously lacking in calcium. They are also as a rule deficient in vitamines so that grain products should be used with foods high in calcium and vitamines such as milk and vegetables. These three, supplying in the largest quantities all the main elements of a complete diet, when taken together form an excellent foundation which can be supplemented by the other foods

The values for vitamines could not be included because the quantitative aspects of this problem have not yet been fully worked out for man. The need for the water soluble vitamines will be covered by an adequate diet of this character and the need for the fat-soluble vitamines is safeguarded by the milk.

It is easy to pick out from this table the food groups which furnish each of the food needs for the least money. In the lists below the cheapest foods are at the top in each list, the next cheapest second, etc.

Calories	*Protein*	*Calcium*	*Phosphorus*	*Iron*
sugar	grains	cheese	cheese	vegetables
grains	nuts	milk	grains	grains
fat	cheese	vegetables	milk	meat
	meats			fruit

In the accompanying charts compare the height of each of the columns that stand for food values with the height of the cost column. Then it will be plain whether or not those foods furnish that food value cheaply. For instance, look at the chart for grain products: a glance will show that in these foods we buy protein, calories, phosphorus and iron cheaply but that grains are expensive sources of calcium. Compare the chart for milk with this: the values are reversed, as milk is a very cheap food for calcium but rather expensive for calories and protein and too expensive to be considered as a source of iron. Now look at the chart for vegetables: vegetables more or less reënforce the food values of milk. Indeed, in the Orient they are used in place of milk, which is scarce. Milk, grains, and vegetables supplement each other and make a satisfactory foundation diet which can be filled out by other foods.



Photographed by Howard H. Cleaves

STORMY PETRELS "WALKING" ON NEW YORK BAY

Wilson's petrels (*Oceanites oceanicus oceanicus*), or "Mother Carey's chickens," are familiar to all ocean travelers and to all dwellers along the Atlantic seacoast. These scavengers of the Atlantic follow in the wake of ships for days at a time, their black and white forms blending with the rolling shadows of the waves or standing out in sharp silhouette against a glassy sea. The petrels are known especially for their habit of walking (or more properly, skipping) upon the surface of the water as they feed on floating morsels, and accordingly it is said they derive their name from St. Peter, the apostle, who walked upon the waves. Moving pictures show that the birds do not advance step by step, but by a kind of two-footed hop. Mr. Robert Cushman Murphy, curator of the department of natural history in the Brooklyn Museum, has demonstrated, through observations made during a long sea voyage and by examination of many specimens, that the petrels of the South Atlantic and those of the North Atlantic are one and the same species, which breeds in remote parts of the Southern Hemisphere and migrates to the Northern Hemisphere during the Antarctic winter (our summer). Mr. Murphy also observed on this voyage that the petrels can dive most skillfully to a depth several times their length

Scientific Zoölogical Publications of the American Museum for 1918

Summary of work on invertebrates, fishes, amphibians, and birds *

By FRANK E. LUTZ

Editor of the *Bulletin of the American Museum*

FOR the most part, papers in the *Bulletin* and *Memoirs* of this Museum are technical in both language and subject matter. Like other papers of the same character they are stones which have been carved for the great Science building and some of them, when viewed separately, may be of no more interest to the unprofessional man than an isolated building stone would be to one who was not an architect. The following brief notes indicate the general setting of these technical publications and point out interesting features of individual papers.

Researches on Invertebrates

One of the *Bulletin* articles[1] describes the anatomy of a leech which lives on the skin of the under side of the flippers of the Floridian green turtle, *Chelonia mydas*. Eight of the *Bulletin* articles and one *Memoir* deal with insects, highly specialized—both in structure and habits—members of the same grand division of the animal kingdom, the Invertebrata, to which leeches belong.

Mr. Olsen[2] reported on the leaf-hoppers which had been obtained from time to time by various expeditions and preserved for study. There are so many thousands of species of insects that no one man can be an authority on all of them; and this Museum has definitely connected with its scientific staff specialists in only three orders. As a result, the material obtained by expeditions cannot be even largely worked up shortly after an expedition returns, but the groups not immediately provided for must await the call of some one actively engaged with the species in question. This was what happened with the leaf-hoppers. Mr. Olsen is an amateur entomologist who is an authority on these creatures, restricting his studies almost entirely to this one family. This paper is, furthermore, an illustration of the mutually helpful coöperation which exists between the American Museum and students and scholars outside of its scientific staff; the Museum stores up more material than its staff is able to study, but this material is eventually used by outside scientists and returned to the Museum properly classified and duly reported upon. It is of interest to note that seven of the nine entomological publications during 1918 were the result of such coöperation.

The department of invertebrate zoölogy has for some time been planning its field work so as to get material for a study of geographic distribution, with special reference to the problems of isolation and of faunal movements between North and South America. As a part of this work the Floridian insects have been carefully studied. The fifth of a series of reports on this part of the work, is by Messrs. Leng and Mutchler[3] on the water beetles of Florida. It lists all the known species and gives distributional and biological notes, together with keys for the identification of certain species.

Mr. Wm. Beutenmüller, when connected with the American Museum, did much work toward the preparation of a monograph on moths of the genus *Catocala*, the moths whose front (upper) wings are usually colored and marked like bark but whose hind wings, covered when at rest, are often banded

[1] MacCallum, W. G., and MacCallum, G. A. 1918. On the Anatomy of *Ozobranchus branchiatus* (Menzies). *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 12, pp. 395–408, Pls. XXXIII to XXXVIII.

[2] Chris E. Olsen. 1918. North American Cicadellidæ in the Collection of the American Museum of Natural History. Subfamily Cicadellinæ. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 1, pp. 1–6.

[3] Leng, Chas. W., and Mutchler, Andrew J. 1918. Insects of Florida. V. The Water Beetles. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 3, pp. 73–116.

* Summary of work on mammals, recent and fossil, will be published in a later number of NATURAL HISTORY.

with bright colors. After the severance of his connection here, the manuscript and drawings were sent for editing to Dr. Wm. Barnes, a physician who owns the largest private collection of moths and butterflies in America and who employs several assistants to work on it. A *Bulletin* article[1] and a superbly illustrated *Memoir*[2] are the result of this coöperation. The *Bulletin* article contains notes on the life histories of twenty-eight species, the outcome of extensive breeding experiments carried on by Dr. Barnes and his assistant, Dr. J. McDunnough, during several seasons. For the most part the experiments deal with species of which the early stages were either partly or totally unknown. The "text" of the *Memoir* consists essentially of the extensive captions of the twenty-two plates, giving notes on synonymy, distribution, etc. The plates are the work of Mrs. Wm. Beutenmüller, together with several by Mr. S. Fred Prince. Seventeen of the plates are in color, showing a large number of larvæ and the adults of most of the American species wonderfully reproduced by the Heliotype Company.

Dr. E. P. Felt, New York State Entomologist and an authority on the small midges, many of which cause galls on plants, examined and reported upon[3] the type material in the American Museum belonging to the family Itonididæ (formerly known as Cecidomyidæ). When an author describes a species that he believes has not been described before, the material which he has before him at the time and from which he writes his description is known as "type" material, and the author usually designates (he always should do so) a single specimen as "*the* type." Subsequent students refer to these types when revising the classification of a group. In this way Dr. Felt made some important changes in the nomenclature of the gall midges and drew up more complete technical descriptions than did the original author. Unfortunately, many authors keep their types in private collections which are difficult of access and subject to all the dangers of storage in a private house and of possible lack of care when the owner's interest lags or he dies. The American Museum offers exceptional advantages as a repository of type material, being in a city which is a center of travel, and having not only fireproof cases in a fireproof building but also a system for the special care of types as distinguished from ordinary specimens.

The red-eyed fruit fly (*Drosophila melanogaster*, formerly known as *D. ampelophila*) has been much used for a study of the laws of inheritance. Dr. A. H. Sturtevant, who has been very active in such work, is also a good student of classification and has written a paper[4] which furnishes keys for the identification of the relatives of this interesting creature as well as notes on their biology and distribution.

White ants, which are really not ants but are more nearly related to dragon flies, have most interesting habits. The paper[5] by Mr. Nathan Banks does not deal with these habits but will help students of termite habits to identify the species with which they are working. Several new species from the American tropics are described. The same remarks apply to Prof. T. D. A. Cockerell's paper[6] on some bees from British Guiana.

Dr. J. Bequaert has published[7] a very full account of the Vespidæ (social wasps and their relatives) of the Belgian Congo. It is based on the collection brought back by Messrs. Lang and Chapin. Keys to and complete descriptions of the species are given, together with copious notes on habits, distribution, etc. The author says of *Synagris:* "No other genus of solitary wasps offers such an amount of interesting ethological problems. Some of the species are still true to the

[1] Barnes, Wm., and McDunnough, J. 1918. Life Histories of North American Species of the Genus *Catocala*. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 5, pp. 147–77.

[2] Barnes, Wm., and McDunnough, J. 1918. Illustrations of the North American Species of the Genus *Catocala* by Wm. Beutenmüller, with Additional Plates and Text. *Mem. Amer. Mus. Nat. Hist.*, III, N. S., Part 1, pp. 3–47, Pls. I–XXII.

[3] Felt, E. P. 1918. Notes and Descriptions of Itonididæ in the Collection of the American Museum of Natural History. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 6, pp. 179–82.

[4] Sturtevant, A. H. 1918. A Synopsis of the Nearctic Species of the Genus *Drosophila* (sensu lato). *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 14, pp. 441–46.

[5] Banks, Nathan. 1918. The Termites of Panama and British Guiana. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 17, pp. 659–67, Pl. LI.

[6] Cockerell, T. D. A. 1918. Bees from British Guiana. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 20, pp. 685–90.

[7] Bequaert, J. 1918. A Revision of the Vespidæ of the Belgian Congo Based on the Collection of the American Museum Congo Expedition, with a List of Ethiopian Diplopterous Wasps. *Bull. Amer. Mus. Nat. Hist.*, XXXIX, Art. 1, pp. 1–384, Pls. I–VI and 267 text figures.

From Bequaert's Revision of the Vespidæ of the Belgian Congo

AN AFRICAN WASP COLONY

Wasps are conveniently distinguished as social or solitary in accordance with the methods they employ in building their nests. The social wasps live in community nests, most commonly made out of a sort of paper which they manufacture by chewing wood; the solitary wasps construct individual mud houses. Members of the American Museum Congo Expedition frequently found on the under side of thatched roofs (a portion shown in the photograph) hundreds of wasp nests (*Synagris cornuta*) constructed from kaolin—a kind of clay used by the natives in whitewashing the walls of their huts. The wasps had sucked moisture from the brook near by and mixed it with the clay which they had then rolled with the front legs and kneaded with the mandibles into the required shape of the nest. This consists of cells each containing a larva and provided with a bent-necked entrance. Each female builds her own nest and feeds one larva at a time from day to day with ground-up caterpillars until it is fully grown; after which the neck of the cell is broken off and sealed for the period of metamorphosis to the fully developed wasp. Two or even three of the necked entrances, however, can sometimes be seen on the same mud lump (not to be confused with the many small holes made by the full-grown wasps in breaking out); each of these necked entrances is attended by one female wasp. In the habit of nesting in dense colonies and of nursing its larvæ from day to day, the horned synagris forms a sort of connecting link between the solitary and the social wasps

From Bequaert's Revision of the Vespidæ of the Belgian Congo

The paper nests of these social wasps (*Polybioides melaina*) of the Belgian Congo are found attached to branches overhanging streams. The outside covering consists of several layers of thin brittle "paper" with numerous entrance and exit galleries. Within this outer envelope the combs of cells in which the larvæ are reared hang side by side. Some of the nests are three feet in length so that with their dense population and numerous exits they become, when in the least disturbed, immediate centers of trouble for the intruding observer. Even Stanley, the first white man to enter this region, found the black wasps worthy of comment and attention

From Bequaert's Revision of the Vespidæ of the Belgian Congo

This photograph shows in natural size a tropical African wasp (*Synagris cornuta*) sitting outside the doorway of her clay nest. The nest was found to enclose four irregularly united cells, one empty and the others containing respectively a fully developed wasp, a translucent white pupa, and a full-grown larva. During the larval stage the wasp is fed daily on a meat diet. To rear the larva from the egg to the full-grown larva at the time when the cell must be sealed requires about one month in the case of this species (the habits of this horned synagris have been explained on the preceding page)

primitive habit of the Eumeninæ, hurriedly accumulating a provision of caterpillars above the egg, then walling the orifice of the cell, and taking no further care of their offspring. In other species, however, the maternal instinct is much more perfect; the female nurses her young from day to day with caterpillars ground up into a paste; this is evidently a transition toward the feeding habits of the true social wasps. Intermediate conditions between these two extremes are also found."

Researches on Fishes and on Amphibians

Mr. Carl L. Hubbs, of the University of Chicago, has written[1] concerning the variation, distribution, habits, and relationships of fishes belonging to the genus *Atherinops* and living on the Pacific coast of North America. They are smelts of several intergrading varieties. After a consideration of the possible migrations leading up to the present distribution of the genus the author says: "It seems probable, on the basis of the evidence available, that the coarser-scaled type of *Atherinops*, subsequent to the northward migration of the finer-scaled type and to the separation of the southern islands from the mainland, has likewise moved northward, meeting the finer-scaled type on the central coast of California. By the interbreeding of the two forms in this region the peculiar hybrid-like intergrades have probably arisen. Now, if this intergradation should spread more widely, or if the typical form on either side should become extinct or differentiated, then, according to the above explanation, we should have a *synthetic* species produced not by divergence but rather by the fusion of two species which were formerly distinct."

Mr. J. T. Nichols, of the American Museum, contributed two taxonomic papers on fishes. One[2] deals with the genus *Vomer*, the material having come from the mouth of the Congo and from the Antilles. The other paper[3] treats of material brought back from Greenland by the Crocker Land Expedition.

A report by Mr. G. K. Noble, assistant curator of herpetology in the American Museum, covers the amphibians collected by the American Museum Expedition to Nicaragua.[4] The Expedition obtained twenty-seven species of frogs and toads, some of these very rare in collections. Two species of amphibians were described as new. One of these belonged to that curious group of Central American salamanders which have their digits bound together by fleshy webs. These salamanders are equally adapted for life in the trees or on the ground. The other new species was related to those tiny Neotropical tree frogs which, in the course of evolution, have dispensed with their vomerine teeth. Frogs of many different genera have become small, and have lost the vomerine teeth. In the Amphibia, teeth as a specific character are structures easily lost or acquired. Two of the tree frogs collected show remarkable adaptation to their environment: *Agolchynis helenæ* has the appearance of a green leaf which has been attacked by leaf mold; its whole back is vivid green with a few scattered spots of yellowish brown. *Hyla boulengeri* is colored very much like the lichens so abundant on the forest trees of Nicaragua. The scene on the Rio Grande, accompanying the report, was taken in the central part of Nicaragua. It was here that the Expedition camped while hunting the many forms of reptiles and amphibians which frequent the river banks of these remote Central American rivers.

Researches on Birds

Mr. R. C. Murphy, of the Brooklyn Museum, added[5] another "Contribution from the Brewster-Sanford Collection." This one discusses the taxonomy, plumages, migration, breeding, and food of the Atlantic petrels, or Mother Carey's chickens, belonging to the genus *Oceanites*. On page 340 is shown a flock of these birds skipping along the surface of New York Bay.

This paper establishes the fact that Wilson's petrel of the North Atlantic is the

[1] Hubbs, Carl L. 1918. The Fishes of the Genus *Atherinops*, Their Variation, Distribution, Relationships, and History. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 13, pp. 409–40.

[2] Nichols, J. T. 1918. On *Vomer dorsalis*, with a Brief Review of the Genus. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 18, pp. 669–76.

[3] Nichols, J. T. 1918. Some Marine Fishes from Northwest Greenland. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 19, pp. 677–83.

[4] Noble, G. K. 1918. The Amphibians Collected by the American Museum Expedition to Nicaragua in 1916. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 10, pp. 311–47, Pls. XIV–XIX.

[5] Murphy, R. C. 1918. A Study of the Atlantic *Oceanites*. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 4, pp. 117–46, Pls. I–III.

same bird as that found in the far South, the southern bird migrating, after its breeding season, to the North Atlantic. This is proved in two ways: first, by a continuous record of migration made from daily observation of the birds between the latitude of New York and 54 degrees south latitude; and second, by a study of specimens taken at many points in the North, South, and tropical Atlantic. The paper also describes for the first time the immature plumage of the petrel, the sequence of molt, and gives new data on the seasons and rate of migration.

Another bird paper is by Dr. Jonathan Dwight. It deals with the snow birds called Juncos and is illustrated by three color plates. The new aspect referred to in its title[1] is given in the author's summary as follows: "Instead of accepting the presence or absence of intergradation as a guide by which to separate species from subspecies, I have endeavored to show that species may be recognized by qualitative, and subspecies by quantitative characters. Specific and subspecific characters in most of the Juncos are almost wholly confined to color and therefore by mapping the geographical distribution of color we are able to gain from a new angle a fairly distinct impression of relationships in this genus. . . . Even if I am overestimating the rôle played by hybrids we very much need a nomenclature that will indicate better than at present the intermediate as well as the extreme portions of lines of variation. Zoölogists and botanists, by actual experiment, have of late years so revolutionized ideas regarding species and hybrids that systematic ornithologists are likely to be looked upon as backward and unscientific unless they learn more of fluctuations and mutations, of manifestations of Mendelian and other laws, and all the modern theory that goes with them."

This Nicaragua frog, *Hyla boulengeri* (Cope), has previously been known only from the type specimen in the National Museum at Washington, described by Cope in 1887. Note its peculiarly long and flat snout. Its coloration gives close resemblance to the patches of lichens on the trees where it lives

A scene in central Nicaragua along the wooded shores of the Rio Grande, haunt of the rare *Hyla boulengeri*. This was one of the camping sites of the American Museum Nicaragua Expedition in 1916

[1] Dwight, Jonathan, 1918. The Geographic Distribution of Color and of Other Variable Characters in the Genus *Junco*: a New Aspect of Specific and Subspecific Values. *Bull. Amer. Mus. Nat. Hist.*, XXXVIII, Art. 9, pp. 269–309, Pls. XI–XIII.

A New Director for the British Museum

SIDNEY FREDERICK HARMER, F.R.S., ENGLISH ZOÖLOGIST, APPOINTED TO THE POSITION PREVIOUSLY HELD BY EMINENT SCIENTISTS, OWEN, FLOWER, LANKESTER, AND FLETCHER

ANNOUNCEMENT comes from London of the retirement of Sir Lazarus Fletcher, F.R.S., from the directorship of the British Museum (Natural History), and of the appointment of Dr. Sidney Frederick Harmer, F.R.S., the present keeper of zoölogy, to fill the vacancy. The retiring director is noted as a mineralogist. He was formerly keeper of minerals in the British Museum, and succeeded Sir E. Ray Lankester as director of the Natural History Museum in 1910.

The appointment of Dr. Harmer was made at a meeting of the Electing Trustees of the British Museum, namely, the Lord Chancellor, the Archbishop of Canterbury, and the Speaker of the House of Commons. His appointment as the director of the Natural History Departments places a zoölogist of distinction in the place of the distinguished mineralogist. Dr. Harmer will retain the keepership of zoölogy until the end of the year 1920. During that period the assistant secretary, Mr. C. E. Fagan, I.S.O., will assist the director in the details of control of the Natural History Museum. Dr. Harmer was formerly a Fellow of King's College, lecturer in zoölogy, and superintendent of the University Museum of Zoölogy. He is a leading authority on invertebrate zoölogy and has published many papers on polyzoa, and with Dr. Shipley, now vice-chancellor of the University of Cambridge, he edited the *Cambridge Natural History*. In 1907 he was appointed keeper of zoölogy at the Natural History Museum, and at once threw himself into his new duties with vigor. He has studied in particular the fauna of the sea, and, following the example of his great predecessor, the late Sir William Flower, he has paid special attention to whales. He has taken a deep interest in the conservation of animals, and has advised the Colonial Office on the preservation of whales and seals. He is one of the vice-presidents of the Zoological Society.

Any event in the development of the British Museum representing, as it does, the oldest and greatest museum of the English-speaking peoples of the world, is of interest to the American Museum. We like to feel that the welfare of our Museum is closely associated with the welfare of the museum in London. The American Museum of Natural History has historical connection through its scientific founder, Dr. Albert S. Bickmore, with the British Museum of Natural History. More than fifty years ago, Dr. Bickmore, after three years (1865–67) spent in the Dutch East Indies, China, Japan, and Siberia, stopped in London on his way home, where he showed Sir Richard Owen, at that time director of the British Museum, the plans for a natural history museum in New York, which had been maturing in his mind during his long journey in the East. Sir Richard expressed general approval of the plan, thereby greatly encouraging the young traveler. Later, when the great ground plan of the American Museum appeared, Dr. Bickmore incorporated in it a large central lecture hall, the feature included in Sir Richard Owen's plans for the British Museum.

Another indebtedness that we feel to the British Museum came through the engagement of Mrs. E. S. Mogridge and her brother, Mr. H. Mintorn, to prepare the first of our bird habitat groups, after methods which had been introduced in the British Museum. They prepared thirty-seven of these small groups for the American Museum, the first series being placed on exhibition in 1887, and the second series a year later. A third, and still stronger bond of union sprang from Sir William Flower's influence on museum development, not only upon the museums of Great Britain, but upon those in this country as well. Sir William was for many years director of the British Museum.

Still another bond exists because of the courtesy of the older institution in welcoming members of the scientific staff from New York to study within the hospitable walls of the British Museum. Such coöperation has been given in the researches of Dr. J. A.

Allen on birds and South American mammals; of Dr. William K. Gregory on fossil and recent primates; of Dr. Daniel Giraud Elliot, for whose great monograph on recent primates every facility was accorded, not only in placing material at his disposal but also in aiding Mr. A. E. Anderson to make many of the photographs for that work at the British Museum; of Professor Bashford Dean and Dr. Louis Hussakof in their work on fossil fishes; and of Professor Henry Fairfield Osborn on the Mesozoic Mammalia, a work which has proved to be of great influence in palæontology. Indeed, there is scarcely a member of the American Museum staff who has not at some time enjoyed the facilities courteously placed at his disposal by the British Museum.

Finally, the two institutions have been brought together more than ever before through the close bonds of allied scientific sympathy which have been created in the great war. Steps are being taken to unite more than one division of the respective museum staffs into similar scientific organizations.

The National Research Council of America, one of the best outgrowths here of the war, is endeavoring to internationalize all the sciences, through a permanent coöperative society. Affiliation in chemistry, astronomy, and palæontology is under way. This suggests and leads the way to affiliation and coöperation between the museums. The American Museum hopes, not only to renew and strengthen the bonds which already exist between the American and British institutions, but also to bring about new means of coöperation and interchange of ideas, with exchanges of specimens and of methods of exhibition.

During the publicity and discussion which have come in England at this time of change of administration in the Natural History Museum there have been expressed certain ideals of the British Museum and of its office of director. These concern the scientific and educational status of the institution and as such are of interest because of their possible wide application. We quote from the London *Times* of February 27, the following, with full agreement: "The director has to represent natural history to the public, to other scientific institutions at home, in the Dominions and Colonies, and in foreign countries, and to the many Government Departments with which the museum has relations. There are few posts with such possibilities of advancing the natural history sciences, of making them useful to the nation, and of interpreting them to the public."

From the *Times* of March 5, we quote the following in order to help in refuting it: "Work in natural history is divisible into two—the formation and study of collections on the one side, and teaching on the other; the former mainly done at museums, the latter at universities."

The truth is that both universities and museums are *teaching* in character although they employ different general methods, and at the present rate of growth of the museum as a practical educator, its future competition with the university is likely to bring modification of method in both institutions.

The further truth is that both institutions are fundamentally *research* in character, with the educational output based on this research. An eminent English naturalist has answered in part this old-fashioned distinction between universities and museums, writing in the *Times* of March 9: "The classification of naturalists into those who teach and those who form and study collections is very loose and misleading. Teaching in science is bound up with research, and research in laboratories is knit into one with research in museums. [The museum research laboratory should differ in no way from the university research laboratory!] There is no sharp division of interest such as your correspondent assumes, either between the universities and the national museums, or between teaching and the collections within the universities themselves."

In the history of museum growth there has been a preliminary time of development of collections, and of accomplishment of a laborious mass of systematic and descriptive work on them. For most groups this work has been pretty well in hand, however, for some years; and the idea that a museum is limited to collections and taxonomy is nowhere extant except in the minds of a few who have not kept themselves informed as to the development of the modern museum.

The Climbing Fish[1]

By R. D. O. JOHNSON

UP IN the Andean heights of the Department of Antioquia, Republic of Colombia, there is a climatic stratum marked by a uniformly cool temperature and great humidity. The rainfall is enormous in quantity. The topography included within the stratum is mountainous in the extreme. The streams are many and torrential in character, and their waters rush roaring down the steep and tortuous channels to the placid rivers of the plains below—they are but a series of falls, cascades, and blustering "riffles." The country rock is schistose in character and comparatively soft and the erosion of the stream beds is very rapid.

Ancient stream beds high up on the cañons' sides are pitted with many potholes of unusual interest to the student of dynamic geology. There is not a waterfall in the region today so small or insignificant that it is not busily engaged in boring out a more or less cylindrical hole in the rock beneath. The falling water at the point of impact seems inevitably to set up a rotary motion, carrying stones, sand, and gravel around with it, and the resulting wear bores out the pothole.

Into these potholes falls the drifting, gold-bearing quartz with which the upper Andean regions abound, and within these mills of nature it is ground to an impalpable powder, and the gold freed from its matrix finds lodgment in the gravels and the alluviums of the plains and the river bottoms. It was the lure of the gold that indirectly drew my brother and myself so far into the jungle—jungle that answers the most rigid definition of the term.

We were employed to install a hydroelectric plant to be used in connection with the operations of a company engaged in placer mining. A permanent camp had been established in niches cut in the steep sides of the cañon and was located at an elevation of 115 feet above the roaring Santa Rita Creek.

Since power streams were numerous, we selected the one most convenient to the camp for beginning our work. The bed of this power stream held an average angle of thirty-eight degrees from the horizontal and, for a considerable distance, slipped down over the smooth surface of the worn rocks in a thin broad sheet.

Our first efforts were directed toward ascertaining the volume of flow of the stream. To do this it was necessary to introduce a measuring weir at a point above the take-off of the plant. The weir was soon established and the deflecting dams were built in. When the water was turned, a part of the bed of the stream lay uncovered, exposing a couple of old gravel-filled potholes. Since such potholes not infrequently contained gold, my brother proceeded to dig out one of them while I was engaged in taking the readings from the weir.

He had been at this task for only a few minutes when he called out to me:

"Say, here's a fish."

I replied saying something about his "seeing things," and proceeded to expatiate upon the impossibility of his finding a fish in such a place, and upon the utter inability of any fish, even among the best swimmers, to surmount the difficulties of such a stream.

I pointed out the absurdity of imagining a fish swimming with nine-tenths of its body out of the water, as it would have to be, up that part of the stream where the water passed in a thin sheet over the smooth rocks. "He'd have to be an aviator," I said. So I pooh-poohed the idea recklessly.

Harry listened with suspicious patience to my lengthy dissertation, while I, from a theoretical standpoint, utterly demolished his unthinking assertion, then he blurted out:

"Well, are you all through? Here's the fish! This is a fact, not a theory you've butted up against."

He held in his hand a living fish, and a catfish at that, resembling the catfish or horned pout of the North. I took it and looked it over. There it was, a real live fish, nearly a half foot long. There could be

[1] "Notes on the Habits of a Climbing Catfish (*Arges marmoratus*) from the Republic of Colombia." By R. D. O. Johnson, *Annals* New York Academy of Sciences, Vol. XXII, pp. 327–333, December 20, 1912.

no possible doubt about it, in spite of the utter impossibility of the thing.

Harry had his laugh and returned to his digging. I was completely puzzled—but I had pressing work to do. I carefully placed the fish in a small pothole at one side. This hole was about four inches in diameter and twelve inches in depth and held perhaps two or three inches of water. Catfish are hardy, so I figured that there was enough water to last this little fellow until I could give him more attention.

After I had finished my work at the weir, I returned to the little pothole to give that amazing fish a closer scrutiny.

He was not to be found, so I called out, "What did you do with the fish, Harry?"

Harry asserted that he had not taken the fish and that he had paid no attention to it. That certainly was a mystery. I did not think it possible for a five-inch catfish to jump out of a four-inch pothole twelve inches deep. I concluded, however, that that was the only way of escape and contented myself with this rather lame explanation.

Before we returned to the camp that afternoon, Harry had caught two more "cats" in another pothole. These we carried down to the camp in our dinner pail. We arrived at the camp just as the late afternoon meal was being served. I hastily poured the water and the fishes from the dinner pail into a three-gallon galvanized bucket and set it in an inconspicuous place outside the kitchen. After dinner I sought the bucket to get a better look at the fishes which had destroyed a good theory. They were not in the bucket. I inquired of several who might possibly have freed the fishes but no one knew anything about them. This mystery was getting too thick for comfort.

The next day I made a special trip up the power stream and managed to secure two more of these fishes. I brought them down to camp and placed them in the same pail that had held the others and sat down to watch their maneuvers.

For a time they were content to swim about, butting their blunt noses against the sides of the vessel. Then, to my amazement, one of them thrust its "nose" out of the water and began creeping up the side of the pail. I watched it hitch itself up by short longitudinal movements until it had reached the top edge and fell outside of the bucket. I put it back and watched the performance repeated. Then I transferred one to a tall glass jar and through the glass watched the operation of the creeping mechanism. I caught others and dissected them and studied them until I was in possession of their secret.

This lies in the combined action of two sucking mechanisms. One of these is the ordinary sucker mouth, surrounded by a soft flap, very thin and flexible at the edges. The other is an interesting structure consisting essentially of a bony plate beneath the skin on the under side of the fish where the ventral fins are attached. These fins are broad and flat and their surface is studded with small sharp teeth pointing backward. The bony plate is given a shuttle action by muscles attached fore and aft so that the fins may be moved lengthwise of the fish through a distance equal to about one sixth its length. With this apparatus the fish is able to create a suction pressure, and by means of the alternate action of the two suckers, it is enabled to crawl, inchworm-like, on a smooth vertical surface.[1]

Shortly after this, the mining company undertook the cleaning out of a large pothole which was eight feet in diameter and twenty-two feet in depth. Before the bottom had been reached, the water that remained in the pothole was found to be full of these climbing catfishes. They were naturally greatly agitated by the action of the workmen who were shoveling out the gravel. Several times some of them started to climb out but were frightened by the men and dropped back. I surmised that as soon as the work was stopped for the lunch hour these fish would essay the long climb to the top. I was not mistaken and my watch-

[1] The climbing catfish which Mr. Johnson describes is not the only species of fish which is able to climb by means of its ventral musculature. In the Himalaya Mountains—so similar to the Andes in ruggedness—there occur several species which have adapted themselves in various ways to this environment. *Nemachilus rupicola* and perhaps other species of mountain cyprinids adhere to the rocks by means of their smooth, ventral skin and enlarged lips. The silurid genera *Pseudecheneis* and *Glyptosternum* cling by means of a well developed abdominal sucker. The mountain torrents of the Himalayas form the nursery for many species of frogs. Their tadpoles, like the fish, have become adapted to these terrific floods. Some of the tadpoles, such as *Megalophrys parna*, cling by means of their lips and the ventral musculature, while other species, such as *Rana afghana*, possess a well developed ventral sucker.
—G. K. N.

ing was rewarded by seeing four climb up a distance of eighteen feet to the pool of water above. They followed a thin film of water that trickled down the rock. This water kept their gills wet and sustained them on a climb that must have been arduous. It required half an hour to make the ascent.

To my own satisfaction I had answered the question of how it was done; there remained the question of why. The fish was evidently a case of extreme modification and adaptation to fit a peculiar environment. Some catfish do not climb, why should these? An analysis of the environment brought the answer.

I found that the Andean torrents were the habitat of myriads of these curious creatures, "capitanes" they are called by the natives. The individuals I had examined were living in a torrential stream almost daily subjected to the sudden fury of sweeping floods. The violence of these floods is unimaginable to one who has not witnessed them. It seems that nothing unanchored in the stream bed can withstand their wild energy. As swimmers, however, these fishes are clumsy and inept. To witness their awkward, wriggling, swimming movements is to know at once that they could not by that means of propulsion alone make any headway against even moderate currents.

We can understand that to remain at home in time of flood, these denizens of the wild waters anchor themselves by means of their sucker mouths. Yet these catfishes are to be found in all parts of the streams, from the slender spring branches of the high mountains to the sluggish rivers of the plains. Travel they must and by using the climbing mechanism I had seen operate—the alternate action of mouth and ventral suction plate. That they are able to surmount even great falls is evident from their presence in the Santa Rita Creek, for this stream falls into the Santo Domingo River over a precipice more than two hundred feet in height.

Notes

MR. EDWARD D. ADAMS has presented to the American Museum the oil painting of the solar eclipse of June, 1918 (reproduced in color in this number of NATURAL HISTORY), by the artist, Howard Russell Butler, N.A. It is the first time in the study of such astronomical phenomena, that the colors of the corona and its prominences have been observed by a trained artist, and recorded at the moment, eliminating the chance of inaccuracy. In connection with this most remarkable painting Mr. Adams writes of the especial interest attached to the 1918 eclipse from the fact that observations of it were confined to the area of the United States. It is true also that it was observed only by people of the United States and Canada, as the great war prevented foreign astronomers from coming to this country to witness the event. The resemblance of the flame at the tip of one of the prominences to the outspread wings of an eagle prompted the association of the eagle with the astronomical event (it was just at the time of the victorious advance of the American and Allied armies) and suggested the use of the term "eagle prominence" in referring to the corona of the eclipse of 1918.

LAWRENCE M. LAMBE, the well-known Canadian palæontologist, died of pneumonia on March 12, 1919. He had been on the palæontological staff of the Canadian Geological Survey for thirty-five years, and for the last fifteen years had devoted especial attention to vertebrate palæontology. In recent years he had come to be regarded as one of the leading authorities on dinosaurs. When the Geological Survey collections were moved to the Victoria Memorial Museum at Ottawa in 1910, he took charge of the fossil vertebrates and succeeded in building up a remarkable collection, especially rich in the Cretaceous dinosaurs of Alberta. In securing this fine material he availed himself of the aid of the veteran American collector, Mr. C. H. Sternberg, and of his sons. The American Museum staff has followed with interest the work and success of Mr. Lambe, as he studied vertebrate palæontology in 1903 under Professor Henry Fairfield Osborn and learned here much of the field technique and methods of research which he applied to Canadian palæontology with such notable results. His unexpected death in the midst of a busy and successful career comes as a shock to his many friends and as a

great loss to the science to which he had devoted his life.

A ROOSEVELT Memorial Exposition to commemorate the life and achievements of Theodore Roosevelt will be held by Columbia University in the Avery Library during May. The University has previously established in Columbia House one of the first of the college centers for Americanization in the country and will establish there a permanent memorial to Colonel Roosevelt.

PROFESSOR and Mrs. Henry Fairfield Osborn, accompanying Mr. C. William Beebe, left New York February 26 to inspect the unusual facilities for research at the New York Zoölogical Society's station in British Guiana. Colonel Roosevelt in 1915 wrote of this station enthusiastically as marking "the beginning of a wholly new type of biological work capable of literally illimitable expansion."

THE Tropical Research Station of the New York Zoölogical Society in British Guiana has reopened for scientific investigation, after a lapse owing to the absence of most of the staff with the American Army. Mr. C. William Beebe, the director, sailed for Bartica on February 26. Bartica is favorably situated for the study of both fauna and flora and its climatic conditions are ideal for the work. General ecological investigation will be made on the relations of plant and animal life in the jungle while special work will be carried on by individual investigators. Professors William Morton Wheeler, of Harvard, Ulric Dahlgren, of Princeton, and Alfred Reese, of West Virginia, will make special study of ants, electric fishes, and crocodiles, respectively, while Director N. L. Britton, of the New York Botanical Garden, will make a survey of the forests. The New York Zoölogical Society assumes the financial support of the project through the generosity of five members of the board of managers, Colonel Anthony R. Kuser, Messrs. C. Ledyard Blair, Andrew Carnegie, George J. Gould, and A. Barton Hepburn.

DR. LIVINGSTON FARRAND, president of the University of Colorado, formerly professor of anthropology in Columbia University (in 1903–4 assistant curator of ethnology in the American Museum), has resigned his administrative work in the university to become executive head of the American Red Cross.

THE establishment of a new Jardin des Plantes is proposed for France in the park of Versailles between the Trianon (villas of Louis XIV and XV) and the Forest of Marly. The new garden of about fifteen hundred acres will be, to a large extent, supplemental to the old Jardin des Plantes in Paris, the further expansion of which has been shut off by the growth of the city.

DR. HENRY ALLAN GLEASON, assistant professor of botany at the University of Michigan, was recently appointed first assistant to the director-in-chief of the New York Botanical Garden, to succeed Dr. W. A. Murrill who occupies the newly created position of supervisor of public instruction.

THE New York Aquarium is to have constructed a seaworthy well boat for purposes of marine collecting. Such a boat with a 10×11 foot well for preserving the fish alive will make possible hereafter the transportation in good condition of not only the local fish of Long Island shores but also the tropical species that migrate in summer up the Gulf Stream, and other large fishes reported taken in the trap nets of local fishermen.

AN example of the development of modern museum methods of instruction in connection with university work is shown in the expansion of the museum of the University of Illinois. The plan includes, in zoölogy, both general synoptic series illustrating the principal forms of animal life, living and extinct, and ecology groups, such as life in and about an old decaying log of the local woods. The first of a series of economic groups to show the presence and activities of common insect pests is also completed.

THE fight of the entomologist against insect pests has been greatly increased during the war. Dr. L. O. Howard, chief of the Bureau of Entomology at Washington, has recently reviewed the work of his Bureau and of the subcommittee on medical entomology of the National Research Council. The

SHARK LIFE IN THE WARM WATERS OF THE SARGASSO SEA

Photograph of a group in the American Museum, recently constructed under the supervision of Dr. Bashford Dean

The blue shark (*Prionace glauca*) is the common surface shark of the open sea, being widely distributed over the Atlantic and Pacific oceans. This species of the high seas is a more slender and graceful fish than most of its relatives and much bluer in color than those species found near the shore. Although not large, it is very voracious and destroys countless smaller fish, even pursuing them into the fishermen's nets. Blue sharks follow ships at sea and collect around whaling vessels to feast on the whales these have taken. The whalers retaliate by eating the sharks. Members of this species sometimes attain a length of ten feet. So far as is known only one specimen has been taken in the vicinity of New York City; this one was caught in 1911 by Mr. Alfred Frank near City Island and was presented by him to the American Museum.

The Blue-shark Group, recently completed at the American Museum, was modeled from a cast of a female shark formerly on view at the New York Aquarium. The shark, with its young, is mounted as though seen from below the surface of the ocean in that tract of comparatively still water in the Atlantic known as "Sargasso Sea" where seaweed and wreckage collect from the ocean currents

Friends of 1st Lieut. Charles L. Camp have learned that at a recent divisional review in France he was awarded the French War Cross with gold star for services in the Argonne. Lieutenant Camp was working in vertebrate palæontology and in herpetology at the American Museum and Columbia University previous to his entering the Army. He has served with the 7th Field Artillery, 1st Division. At present he is giving courses in history to the men of the 18th Infantry. In telling his father of the honor he has received, he wrote, "Those who most deserve the decorations are, however, underground."

fighting of disease carriers occupied the attention of all governments from the very first. Body lice, carriers of typhus and, as was later discovered, of the very general trench fever, were thoroughly investigated and reported upon in England, France, and Germany before the United States began massing troops; but extensive experiments were later conducted in this country, in cooperation with the Chemical Warfare Service, as to the possible utilization of war gases as fumigants against this pest, and an overhauling of army laundering processes was undertaken with a view to complete sterilization of clothing.

The work of the Bureau in protecting crops, ground supplies, and lumber is perhaps more generally familiar to the public, although Dr. Howard says the preëminently practical men who have been working for years along this important line were "chagrined to find that even in certain high official circles the old idea of the entomologist still held—that he was a man whose life was devoted to the differentiation of species. . . ." The stimulation of food and lumber production was one of the most important of our home activities. In assisting the farmer the duties of the Bureau were, as usual, multifarious, as, for example, the heading off of a plague of grasshoppers in Kansas, thereby saving about $3,000,000 worth of wheat and $2,500,000 worth of alfalfa. The cultivation of castor beans for their oil arose as a special war measure inasmuch as the entire Mexican crop was bought up and shipped to Spain, probably to German agents. A large acreage of these beans was planted in the United States which the southern army worm and other insects quickly discovered and the entomologists were called in to prevent an insect raid. Inspection and protection of the great stores of grain, lumber, and wooden implements also fell to the entomologists and they found it necessary to investigate the ways and means of getting out logs so as to prevent their destruction by borers. Aside from this cooperative research, entomologists were also commissioned in the Army for medical work and their services received well merited praise from the Army authorities.

A TALE of "pheasant farms" in China where thousands of golden and silver pheasants supposedly are raised for their plumes

has grown up and lately been brought to the attention of the United States Treasury Department with reference to a proposed importation of the plumage. The New York Zoölogical Society has investigated the matter and found the report untrue. Mr. C. William Beebe, curator of birds at the Zoölogical Park and author of the recent monograph on the pheasants, and Mr. Roy C. Andrews, leader of the American Museum's expeditions to China, both deny the existence of any such farms in southwestern China. Dr. Hornaday wrote also to the French Consul at Mongtseu who further denied the reports.[1] The golden and silver pheasants, the consul reports, have never been domesticated and usually die in captivity. Certain of the aboriginal non-Chinese tribes of Yunnan do keep male pheasants for decoy birds in order to attract the hens in spring, but such decoy birds bring $13 (Mexican) while a pheasant for the table can be purchased in the mountain country for thirty or forty cents. The exportation of living pheasants or their plumage is absolutely prohibited in China and Indo-China, and the authorities are very much interested in preventing commerce in the feathers for, if the price should chance to rise, the natives would soon destroy the species.

A CHINESE encyclopedia[2] has recently come from the Oxford Press. This is the first work of the kind that has ever appeared on China. "I send out the *Encyclopædia Sinica*," writes the editor, "in the sincere hope that it may help to interpret and open up China to the foreign reader, and may increase mutual respect and knowledge between East and West." Many topics on the natural history of China are included and extensive bibliographies given; for example, under "ornithology" Mr. J. D. de La Touche lists 155 articles and books. Mr. Norman Shaw, author of *Chinese Forest Trees and Timber Supply*, contributed most of the material on the products and exports of China and supplied many of the statistics. Many other distinguished authorities and Government Ministries and Services contributed important articles.

[1] *Bulletin de la Ligue Français pour la Protection des Oiseaux*, Nov.–Dec., 1918.

[2] *The Encyclopædia Sinica*, by Samuel Couling, formerly Honorary Secretary and Editor of the North-China Branch of the Royal Asiatic Society, London, 1917.

IN spite of revolutions and brigandage in China, the academic work at the West China Union University, Chengtu, has continued at maximum capacity. Chengtu lies not far from the inland port of Chungking. It is the capital of the rich province of Szechwan, the governmental and educational capital for 45,000,000 people and an important center of commercial enterprise and political reform. The city is located at the beginning of the ancient caravan route to Tibet and is even today the center for the great drug exporting trade from that almost unknown plateau. The last ten years have seen the creation of this modern university in Chengtu and its hearty approval by the Chinese. Not the least successful feature of the university is its buildings modeled after Chinese designs. Western attempts to imitate Chinese architecture have usually been failures, but the Chinese designs of the university's colleges and halls were an important factor in winning Chinese approval of the institution.

THE Reverend Harry R. Caldwell, representing the Methodist Episcopal Church as missionary at Yenping, Fukien Province, will join Mr. Roy C. Andrews in October for field work in China under the auspices of the American Museum. The Reverend Mr. Caldwell assisted Mr. Andrews in 1916–17 in the Fukien Province, notably in an attempt to shoot a melanistic Chinese tiger, the "blue tiger," the story of which was narrated in the AMERICAN MUSEUM JOURNAL for May, 1918.

IN answer to a question regarding the speed of the Mongolian antelope (*Gazella gutturosa*), Mr. Roy C. Andrews writes from China again that he has "no hesitation in placing this at sixty miles an hour." "At one time," he says, "our car was running at forty miles (by the speedometer) and a herd of antelope which had started when nearly opposite to us and about three hundred yards away, ran parallel with us for some distance and then gradually drew ahead and crossed in front; they kept about the same distance away all the time. In other words while we were running forty miles in a straight line they were going in a semicircle about us and still keeping almost the same distance away —perhaps they lost fifty yards, but not more. When we began to shoot, the animals in-

creased their speed very considerably and the man with me estimated then that they were running about seventy miles an hour; there is no doubt that they can run sixty miles with comparative ease. I never knew what running was until I saw those antelope —they simply flew, and one had a strange impression that they were skimming the ground, for their legs appeared only as a blur."

To meet the growing demand for trained gardeners, and to afford convalescent soldiers and sailors opportunity for preparation for such work, the New York Botanical Garden has inaugurated a two years' course in practical gardening. The remarkable natural facilities of the grounds comprising the Botanical Garden in Bronx Park, New York City, offer an unusual opportunity for training in this subject, while in addition the extensive library of horticultural books and the well equipped laboratories will be at the disposal of students. The instruction by the staff of the Botanical Garden will combine indoor lecture and laboratory classes with outdoor gardening. During the first year, classes will be conducted in such elementary scientific studies as elementary botany, zoölogy, plant physiology, and chemistry, and practical training given in greenhouse practice, flower gardening, and vegetable and fruit gardening. The second year's course has not yet been announced, but will include such advanced subjects as surveying, garden design, garden pathology, and garden mycology.

THE artistic planting of trees along roads not only adds beauty to the countryside, but also helps to preserve the roadbed and to break wintry winds. The possibilities in this form of highway improvement have just been presented for public consideration in a *Circular of the New York State College of Forestry* by Professor Henry R. Francis. New York State, with its network of improved highways, offers a splendid opportunity for roadside tree planting. Roadside conditions at present are entirely haphazard and the care of the trees has been neglected or left in the hands of those unskilled in either landscape gardening or arboriculture. Recently a bill has been introduced in the state legislature to amend the highway law with a view to such improvement, providing for the appointment of a highway tree warden who shall be a scientific forester with practical experience along the lines of landscape engineering. The bill asks for an appropriation of $10,000 for carrying out the provisions of the act, and $10,000 for an initial demonstration on the state highway between Syracuse and Utica.

THE Springfield Massachusetts, natural history museum is to have special classes conducted Saturday afternoons by the junior high school art teachers. This plan grew out of the exceptional results obtained by school children of the city who have been working with pencil, brush, and clay on various museum subjects. One boy, becoming interested in the dinosaurs, executed a clay model of such merit as to warrant its receiving a place in the permanent exhibit of the museum. The Saturday afternoon lectures which have been given on various subjects have proved an inspiration to these youthful artists and it is expected that the inauguration of art classes will attract many students. This coöperation between art and natural history is an illustration of the complementary nature of much of the work of institutions traditionally looked upon as far apart in interests.

ONE of the best known founders of the American Ornithologists' Union is Mr. William Brewster, of Cambridge, Massachusetts, who served as its president from 1895 to 1898. Before the organization of the Union and for many years since, Mr. Brewster has been president of the Nuttall Ornithological Club, the oldest bird club in America, still in existence. He has devoted much attention to the development of his private ornithological museum, a unique institution at which the Nuttall Club holds its meetings and which recalls many pleasant memories in the minds of those bird students who have been fortunate enough to enjoy its hospitality. While primarily a systematic ornithologist, Mr. Brewster has always devoted much attention to the study of birds in the field, and as an accurate and skillful describer of their habits he is today without a peer.

THE marine research of the Carnegie Institution[1] was somewhat modified during the

[1] "Department of Marine Biology," Carnegie Institution of Washington, *Year Book* No. 17, pp. 149–172.

past year on account of the war, and the work begun at Tortugas, Florida, had to be postponed, the yacht "Anton Dohrn" being in the service of the Navy. The director, Dr. Alfred G. Mayor, accompanied by Professor A. L. Treadwell, Duncan Gay (artist), and Mr. John Mills (engineer), made a two months' trip to Tobago, British West Indies, where collections were obtained and extensive studies were made of siphonophores (jellyfish, etc.), and of the Eunicidæ (marine worms). Especial attention was paid to the question of the southern distribution of the West Indian marine fauna and the influence of South America upon it.

Further trips to the West Indies being prevented by the appearance of enemy submarines off our coast, the director, with Professor L. R. Cary and Mr. John Mills, visited Pago Pago, American Samoa, to continue studies of the coral reefs begun the previous year. The results of these two voyages show that certain stony corals (Madreporaria) of the Pacific grow twice as rapidly as do similar corals of the Atlantic. An *Acropora*, for example, increased sixty-eight ounces in the fifteen months. This genus is the most important element in the outward growth of the Samoan reefs. The *Porites*, which form irregularly rounded masses dangerous to navigation, grow at the rate of about one inch a year. Drilling through the fringing reef at Pagopago, Professor Cary found it to be 121 feet thick and underlain by volcanic rock. Further study will be taken up on another trip when examination of the precipitous outer edge will be made by the use of diving hoods. The more rapid rate of growth of the Pacific corals evinces the fact that the present reefs may have attained their growth during the last 30,000 years or since the last Glacial Epoch. The greater rapidity is probably due to a better food supply.

During the voyages continual tests were made of the acidity and alkalinity of the surface waters of the ocean and the results obtained may be of importance to navigators. For example, the water of the Gulf Stream is much more alkaline than that which drifts down the east coast of North America, so that a navigator, entering or leaving an Atlantic harbor, could easily determine his position with reference to it. Arctic water and water from great depths is more heavily charged with carbon dioxide than warm surface waters and so maintains a higher state of acidity.

"THE Superb Position of New York City as a Center for Physiographic Study" is the title of a paper by Dr. A. K. Lobeck [1] which

[1] *Annals of the New York Academy of Sciences*, Vol. XXVIII, pp. 1–50.

Poh-we-ka (Little Blue Corn Flower), or Marie Martinez, a young Tewa woman of San Ildefonso pueblo who is attempting to keep alive the ancient symbolic art of the pottery of her people. Some of the best pottery of the eastern Pueblos was made at San Ildefonso. The designs are filled with meaning and refer mostly to clouds, rain, mountains, and vegetation; in fact, these designs are in part prayers for the life-giving rain. Marie Martinez and her husband are fully acquainted with the ancient pottery excavated from villages in Pajarito Park (one of our national monuments) as well as with the more recent productions of San Ildefonso (Photograph by courtesy of *El Palacio*)

points out the unusual variety and completeness of the illustrations of earth sculpture within a radius of three hundred miles of the metropolis. In fact a great wealth of geological and physiographical material may be reached by half-day trips, or even within the city's limits. The various agencies of erosion are all typified in the vicinity. Both young and mature rivers are found and indeed the Bronx River alone illustrates both stages in its upper and lower stretches respectively. The Hudson presents the very old stages of river ageing with further reference to repeated uplift and renewal as is seen in the stepped peneplains of its valley walls. The relation of streams to dividing ridges and the subject of stream "capture" may also be mentioned, especially the excellent example in the Catskill Mountains where the Kaaterskill has diverted the headwaters of Schoharie Creek.

The great continental glacier reached its maximum expansion at New York so that here we find the various effects of ice erosion, terminal moraines, and erratics, or rocks carried in the ice from great distances.

Well defined coastal plains lie within easy reach to the south, especially along the New Jersey coast, and here are illustrated the economic dependence of people on topographic features and the determination of routes of travel by them. In the Alleghenies, throughout Pennsylvania and New York, we find examples of folded mountains, while among the Adirondacks, the White, and the Green Mountains stand carved and worn down masses of complex ranges. The only important feature not well represented is the phenomenon of volcanicity although there are roots of old volcanoes like Ascutney Mountain in Vermont and long intrusive ridges like those forming the Palisades.

Not only is this region most accessible to the student located in New York City, but, in addition, there is no section of the country which has been so thoroughly worked over, mapped, and described so that both the amateur and the expert geographer and geologist have at their command a great wealth of literature. Dr. Lobeck gives an extensive bibliography of the region.

MRS. HENRY FAIRFIELD OSBORN has recently presented to the Osborn Library of the American Museum a number of private letters written by Charles Lyell, the great English geologist. These date from 1836 and are addressed to Dr. Benjamin Silliman, founder of *The American Journal of Science* (which celebrated its centenary in July, 1918), and at that time professor of "chemistry, mineralogy, etc.," at Yale.

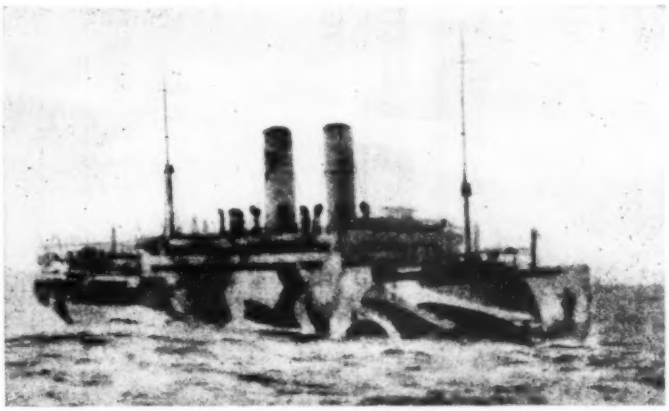
Lyell's fame was world wide and his works on systematic geology were the standard world treatises and texts in that science. Most of the letters are concerned with business items relative to the publication and sale of these books in the United States—a matter which Professor Silliman, as America's most noted geologist, was eager to promote. Lyell's volumes were undergoing constant revision as contemporary investigation advanced and as he himself traveled into new lands, and the proposed edition of the *Elements with notes and additions in American Geology* came in for discussion with Professor Silliman, especially in that part of the correspondence exchanged during Lyell's American trip. Continual personal mention of Darwin and other historical characters gives an added interest to the manuscripts. Mrs. Osborn's gift reverts attention, in these days of stenographers and typewriters, to the time when the world's greatest scientists and most industrious investigators laboriously wrote their letters with pen and ink on both sides of the paper.

M. FÉLIX SARTIAUX is preparing a French translation of the *Origin and Evolution of Life,* by Prof. Henry Fairfield Osborn, which will be issued from the press of Masson et Cie. M. Sartiaux, the author of *Troie—La Guerre de Troie* (1915) and *Morale Kantienne et Morale humaine* (1917), is an authority both in the archæologic and philosophic fields.

THE close of hostilities has released considerable discussion on the question of marine camouflage and its relation to the theory of protective coloration of animals. There are two general types of marine camouflage: (1) the low visibility patterns intended to make the ship invisible or indistinct at medium ranges; (2) the British "dazzle," constructed of prominent patterns which serve to break the outline of the ship and to render calculation as to her length, speed, direction, and distance inaccurate. In order to "paint out" the ships it was found that monochromes were never as ef-

fective as the contiguous application of the various colored constituents of the shade of gray. Accordingly the ships bore spotted coats of red, green, and violet, either one of which colors will predominate as the light changes in the resultant gray transmitted to the eye.

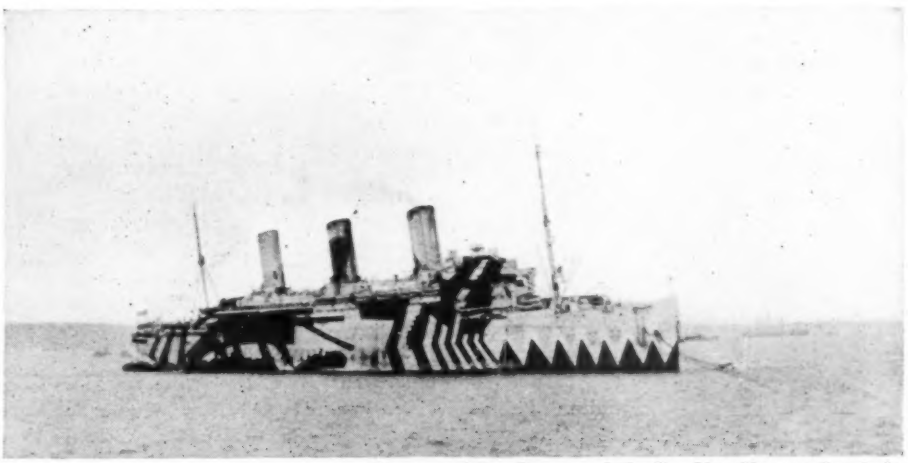
Mr. Robert Cushman Murphy,[1] curator of the department of natural history in the Brooklyn Museum, has pointed out in this connection the interesting living example of low visibility, the whale bird (*Prion*) of the subantarctic Atlantic, whose dominant hue is practically identical with "omega-gray," the color devised by the Navy for low visibility in high latitudes. The invisibility of this bird against the waves is also due to shading and a slight pattern of light and dark bands. A combination of this nature was ultimately found to be most successful for protecting ships. By means of stripes and other "dazzle" figures all vertical and horizontal lines are eliminated so that it is nearly impossible to see the prow or tell in what direction it points. These stripes also destroy the perspective to such an extent that a range finder will miss the range by many meters. In addition to the



Courtesy of Sea Power and the Brooklyn Museum Quarterly

Early attempts at the production of a "dazzle" were not very effective. This photograph of the British transport "Tuscania," taken the day before she was sunk, represents rather the vagaries of vorticists than any systematic method of deception. The practical effectiveness of the later types of camouflage is well established, however, as naval records show definitely the greater "chance of life" of the protectively painted ship

[1] "Marine Camouflage," *The Brooklyn Museum Quarterly*, Jan., 1919, p. 38.



Courtesy of Sea Power and the Brooklyn Museum Quarterly

The "Vaterland," the largest ship afloat, stripped of her dazzling lights, rechristened the "Leviathan," and given a new "dazzle," represents the best in marine camouflage. The "Leviathan" is here shown painted with a low-visibility dazzle, the essential elements of which are (1) the juxtaposition of colors which, when seen at a distance, will combine to form a neutral tint, and (2) the "painting out" of all horizontal and vertical lines which might fit the scale of a range finder. Especially noticeable are the series of dark triangles at the bow. These triangles gave the impression of a series of prows and so completely confused judgment as to the ship's direction that she was almost a menace to her convoy

Courtesy of Sea Power and the Brooklyn Museum Quarterly

A living example of protective marine coloration is found in the whale bird (*Prion*) of the subantarctic Atlantic. The color of this petrel is a neutral blue-gray, not unlike the "horizon blue" of French field uniforms and of substantially the same wave length, saturation, and reflecting power as "omega-gray," the shade used by the Navy for low visibility. It is said that the latest British experiments in airplane camouflage point toward designs and colors similar to those of *Prion*

confusing dazzle, however, the color scheme for the stripes and figures is so selected that the color combinations fuse at a distance into a blue gray of low visibility.

A MODEL of a killer whale, the so-called "wolf of the sea" (*Orca orca*), posed as if making an attack on a sulphur-bottom whale, is now completed and on exhibition in the American Museum. The killer is a small whale of no commercial value but distinguished from other whales by its great strength and ferocity. It preys on warm-blooded sea animals such as seals and sea lions and attacks other whales, biting off the ends of their flukes and flippers and tearing out their tongues. Killers hunt in "packs." When attacking, they bellow in a way that paralyzes their prey with fear. The present model is a life-size reproduction, twenty-two feet long, built with a wooden framework planked diagonally in basswood and covered with wire netting. This surface is filled with a coating of white lead and whiting over which the final paint is laid. A structure of this nature eliminates the great weight which would encumber a plaster cast. Mr. Otto Block, of the American Museum's preparation shops, constructed the model under the supervision of Director F. A. Lucas, from measurements and photographs taken by Mr. Roy C. Andrews, of a specimen captured on the Pacific Coast.

THERE has recently passed out from within the American Museum's walls an organization whose work has now become history. Local Board, Division No. 129, of the city of New York, here since the inauguration of the draft, has quietly proceeded in its work of choosing men for the United States Army. On the occasion of final departure the President of the Museum received a letter of appreciation from Mr. Julius Henry Cohen, chairman of the Board, in the course of which he said: "There appears nowhere a record of this contribution which the American Museum has made to the great service of winning the war, but our Board has an indelible record; it has a very definite memory of the spirit of cordiality and helpfulness displayed by every one connected with the Museum with whom our work brought us in contact."

MR. GEORGE K. CHERRIE, ornithologist and field naturalist, has returned from Venezuela with a large collection of birds for the American Museum. Mr. Cherrie, well known to readers of NATURAL HISTORY and of Colonel Roosevelt's *Through the Brazilian Wilderness*, has had a long and varied experience as a collector in South America, making twenty-eight expeditions into tropical America and visiting every country in the southern continent except Chile. Mr. Cherrie took his latest journey alone, except for an attendant, and lived for weeks at a time on the native diet of corn and goat's milk. His recent collection contains about eight hundred specimens of great variety and scientific interest.

"A MOST interesting modern development," observes the Report of the British Educational Mission, "is the increasingly important part played by the museums, not only in respect of educational visits of school children, popular lectures, etc., but, as at the Natural History Museum of New

York, by means of traveling collections sent out to schools." In this connection it is interesting to report that the Department of Education of the City of New York has made a supplementary appropriation of $4100 to renew the popular lecture courses for children and the distribution of nature collections to the schools, which had been suspended for a time for reasons of war economy.

THERE are only two remaining colonies of gannets on the North American coast, one on Bird Rock near the Magdalen Islands, the other on Bonaventure Island in the Gulf of St. Lawrence. The rookeries of the latter are described in a recent *Ottawa Naturalist*. The seaward face of Bonaventure Island is a vertical cliff rising about three hundred feet from the sea. "Approaching this side from the sea, one is aware that every ledge and shelf is covered with white as though snow had piled in drifts upon them, allowing only the overhangs to show dull red between the glistening surfaces. A wind seems to stir the white masses, and they blow off in eddies and clouds of great white birds that swirl about the cliff faces and circle round the intruder amid a pandemonium of hoarse cries. These are the gannets, the solan geese of older authors, each as large as a goose, pure white with black wing tips. . . ." NATURAL HISTORY will publish in its next issue an article by Director John M. Clarke, of the State Museum at Albany, on the protection of these bird colonies.

THE possibilities in the utilization of peat are illustrated by a large exhibition at the Commercial Museum of Philadelphia. We usually associate peat with poor communities which cannot afford coal and must turn to the swamps for fuel, but in some places in Europe peat commands a higher price than the coal for which it is supposed to be a substitute. In this country we have about 11,188 square miles of peat bog which would produce more than twelve billion tons of fuel. So far this natural resource has been almost unexploited. Numerous other uses of peat are explained in the Philadelphia exhibit, such as the spinning of fibrous peat into yarn and its manufacture into paper; its use for packing; and its value as a preservative because it contains large amounts of humic acid. Ground up peat may also be used as a filler for fertilizer, making possible the use of slaughterhouse waste, and as a filler for stock feed, such as molasses, which could not otherwise be fed to animals. Insulations, sound-proof boards, paving stones, and even alcohol are among its manufactured products.

Two publications[1] in the field of California zoölogy have recently appeared. One is an exhaustive treatment of the game birds of that state, including an account of their life histories, which should appeal to the hunter as well as the naturalist and serve as a basis for intelligent legislation on the matter of bird protection. The other treats of the ground squirrels of California and supplies information of importance to the farming interests with reference to a number of species inimical to the crops.

[1] *The Game Birds of California.* By Joseph Grinnell, Harold C. Bryant, and Tracy I. Storer. Octavo, pp. 642, with 16 color plates by Louis Agassiz Fuertes and Allan Brooks.
The Ground Squirrels of California. By Joseph Grinnell and Joseph Dixon.

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum:

Annual Members, MESDAMES THOMAS K. GALE, J. H. LANCASHIRE, MISSES HATTIE W. PERKINS, EUDORA D. SNYDER, CAPT. CLINTON PELHAM DARLINGTON, DOCTORS ANDREW N. AVINOFF, EDWARD S. COWLES, HENRY F. MERRIAM, J. B. PARDOE, W. C. TWISS, MESSRS. C. LUDWIG BAUMANN, FREDERICK S. BLACKALL, CHARLES ANDERSON CASS, ROBERT M. DONALDSON, GEORGE B. GORDON, WILLIAM WEBSTER HALL, WILLIAM F. HEIDE, EDWIN W. INSLEE, FRANÇOIS KLEINBERGER, ERNEST A. NEILSON, M. NEWBORG, HAROLD OTIS, ALBERT F. THALHIMER, SAML. G. TIBBALS, S. W. TRAWICK, and JOSEPH B. WHITNEY.

Associate Members, MRS. ELIZABETH M. MOLINEUX, MISS ROSE DOUGAN, DOCTORS ALBERT H. FREIBERG, W. P. MANTON, WALTER E. NEWCOMB, H. W. OSBORN, MESSRS. FRANK DABNEY, DANIEL HOWLAND, EDWIN F. MACK, EDWARD P. WELLS 2D, WALTER D. WILCOX, ROBERT C. WRIGHT, and GEORGE W. YORK.

The American Museum of Natural History

Its Work, Membership, and Publications

The American Museum of Natural History was founded and incorporated in 1869 for the purpose of establishing a Museum and Library of Natural History; of encouraging and developing the study of Natural Science; of advancing the general knowledge of kindred subjects, and to that end, of furnishing popular instruction.

The Museum building is erected and largely maintained by New York City, funds derived from issues of corporate stock providing for the construction of sections from time to time and also for cases, while an annual appropriation is made for heating, lighting, the repair of the building and its general care and supervision.

The Museum is open free to the public every day in the year; on week days from 9 A.M. to 5 P.M., on Sundays from 1 to 5 P.M.

The Museum not only maintains exhibits in anthropology and natural history, including the famous habitat groups, designed especially to interest and instruct the public, but also its library of 70,000 volumes on natural history, ethnology and travel is used by the public as a reference library.

The educational work of the Museum is carried on also by numerous lectures to children, special series of lectures to the blind, provided for by the Thorne Memorial Fund, and the issue to public schools of collections and lantern slides illustrating various branches of nature study. There are in addition special series of evening lectures for Members in the fall and spring of each year, and on Saturday mornings lectures for the children of Members. Among those who have appeared in these lecture courses are Admiral Peary, Dean Worcester, Sir John Murray, Vilhjálmur Stefánsson, the Prince of Monaco, and Theodore Roosevelt. The following are the statistics for the year 1918:

Attendance in Exhibition Halls	627,302
Attendance at Lectures	64,036
Lantern Slides Sent out for Use in Schools	72,287
School Children Reached by Nature Study Collections	817,610

Membership

For the purchase or collection of specimens and their preparation, for research, publication, and additions to the library, the Museum is dependent on its endowment fund and its friends. The latter contribute either by direct subscriptions or through the fund derived from the dues of Members, and this Membership Fund is of particular importance from the fact that it may be devoted to such purposes as the Trustees may deem most important, including the publication of NATURAL HISTORY. There are now more than four thousand Members of the Museum who are contributing to this work. If you believe that the Museum is doing a useful service to science and to education, the Trustees invite you to lend your support by becoming a Member.